SELECTED
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RESOURCES
ABSTRACTS

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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

S elected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several services of the Water Resources Scientific Information Center. The cumulative SWRA file from 1968 and monthly updates are available also in magnetic tape through lease from NTIS.

THE WATER RESOURCES SCIENTIFIC INFORMATION CENTER DOES NOT PROVIDE COPIES OF DOCUMENTS ABSTRACTED IN THIS JOURNAL. Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
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05 WATER QUALITY MANAGEMENT AND PROTECTION

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SELECTED WATER RESOURCES ABSTRACTS

1. NATURE OF WATER

1A. Properties

UPWELLING LIGHT STREAM IN NATURAL WATERS.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Plant Industry.
J. T. O. Kirk.
Limnology and Oceanography LIOCAH, Vol. 34, No. 8, p 1410-1425, December 1989. 8 fig, 4 tab, 16 ref.

Descriptors: *Euphotic zone, *Light penetration, *Natural waters, Backscattering, Monte Carlo method, Photons, Simulation.

As a contribution to the study of radiant flux, a study was conducted by the Monte Carlo simulation technique of the behavior of photons scattered upward from the downwelling light stream within water bodies. Immediately after scattering, the angular distribution of these photons is biased very much toward small angles to the horizontal. Consequently, the rate of attenuation of the photon population as it travels upward is initially very high. With increasing distance upward, the rate of attenuation diminishes progressively as the more horizontally traveling photons are selectively extinguished. The upwelling flux at any depth originates in upward scattering events at lower depths, mostly within quite small optical distances below the reference depth. A new parameter, kappa(zeta), is defined; it is the average upward vertical attenuation coefficient exhibited by all the upwelling photons received at depth zeta meters as they travel upward from their point of origin by upward scattering to depth zeta. Kappa is always far greater than K sub d (the vertical attenuation coefficient for downward irradiance in that water) and, to a reasonable approximation, kappa approximates 2.5 K sub d in the middle of the euphotic zone. The diffuse backscattering coefficient for the downwelling light stream is approximately equal to the irradiance reflectance for the downwelling light stream multiplied by (K sub d + kappa). Based on this relationship, a new method was developed for estimating the scattering coefficients of water bodies from irradiance data. (Author's abstract)
W90-08965

NUMERICAL MODEL FOR THE COMPUTATION OF RADIANCE DISTRIBUTIONS IN NATURAL WATERS WITH WIND-ROUGHENED SURFACES.
Joint Inst. for the Study of the Atmosphere and Ocean, Seattle, WA.
For primary bibliographic entry see Field 2H.
W90-08966

2. WATER CYCLE

2A. General

HYDROLOGY OF FOUR HEADWATER BASINS IN THE SIERRA NEVADA.
California Univ., Santa Barbara. Center for Remote Sensing and Environmental Optics.
R. Kattelmann.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 141-147, 3 fig, 3 ref.

Descriptors: *Forest watersheds, *Headwaters, *Headwaters hydrology, *Hydrological regime, *Sierra Nevada Mountains, *Snowmelt, Discharge hydrographs, Flood hydrographs, Flood peak, Precipitation, Rainfall-runoff relationships, Snow density, Streamflow, Surface-groundwater relations.

The Teakettle Creek Experimental Forest was established on the Sierra National Forest in 1936. Four headwater streams in the Experimental Forest are controlled by weirs and have been monitored intermittently over the past 50 years. This streamflow record and some ancillary data permit a rough examination of the hydrology of these forested catchments in the southern Sierra Nevada. Winter snow accumulation and spring snowmelt are the primary influences on the annual hydrograph. However, groundwater release keeps streamflow relatively high well into summer, and all peak flow events have resulted from mid-winter rain-on-snow events. These rain-on-snow peaks have been up to five times greater than spring snowmelt peak flows. Annual runoff has varied from < 12 cm to > 150 cm over the period of record. Evapotranspiration appears to be relatively consistent from year to year with a mean of about 60 cm and accounts for about half of the annual average precipitation. (See also W90-08822) (Author's abstract)
W90-08838

RECENT TRENDS IN GLACIERS AND GLACIER RUNOFF, WIND RIVER RANGE, WYOMING.
Wyoming Univ., Laramie. Dept. of Geography and Recreation.
For primary bibliographic entry see Field 2C.
W90-08840

GROUNDWATER CONTRIBUTIONS IN AN ALPINE BASIN IN THE SIERRA NEVADA.
California Univ., Santa Barbara. Santa Barbara Remote Sensing Unit.
For primary bibliographic entry see Field 2F.
W90-08859

TRACING STORMFLOW SOURCES IN SEEPAGE ZONES USING OXYGEN-18.
Pennsylvania State Univ., University Park. School of Forest Resources.
D. R. DeWalle, and H. B. Pionke.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 511-516, 2 fig, 1 tab, 6 ref.

Descriptors: *Headwaters hydrology, *Isotopic tracers, *Pennsylvania, *Soil water, *Storm seepage, *Surface-groundwater relations, *Tracers, Groundwater, Rainfall, Storm runoff.

Oxygen-18 content of water samples was used to trace the appearance of rainfall, pre-event soil water and shallow groundwater in seepage zones and stream stormflow for one November, 1988 rainfall event on a central Pennsylvania catchment. Streamflow O-18 content before and after the event resembled that of shallow groundwater and soil water. During rainfall, streamflow and seepage water O-18 content indicated that rainfall was contributing from 22 to 47% of total flow. After rainfall ceased, O-18 content of seepage water at two sites indicated a mixture of about 1/3 soil water and 2/3 shallow groundwater were being discharged at the surface. Results support the hypothesis that both pre-event soil water and shallow groundwater from seepage zones contribute to and likely dominate stormflow in upland catchments. (See also W90-08822) (Author's abstract)
W90-08873

HYDROLOGIC PRODUCTION ZONES IN A HEADWATER WATERSHED.
Northeastern Forest Experiment Station, University Park, PA.
For primary bibliographic entry see Field 2E.
W90-08879

DEFINING HYDROLOGIC CHARACTERISTICS OF HEADWATERS FORESTED WATERSHEDS IN THE SOUTHERN INTERIOR OF BRITISH COLUMBIA.
British Columbia Ministry of Forests, Kamloops.
J. D. Cheng, D. E. Reksten, and P. F. Doyle.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 579-588, 5 fig, 1 tab, 10 ref.

Descriptors: *Forest watersheds, *Headwaters, *Headwaters hydrology, *Hydrologic regime, *Rainfall-runoff relationships, *Runoff, British Columbia, Flood peak, Okanagan River Basin, Snowmelt, Streamflow.

Headwaters forested watersheds supply nearly all the water used in the Okanagan Basin in the southern interior of British Columbia. Spatial variation in mean annual water yield (45-420 mm) of these headwaters watersheds is closely related to the variation in mean annual precipitation (500-1 000 mm). Peak flows occurring in May-June snowmelt season are moderate in magnitude (0.02-0.30 cu m/s/sq km) and low flows in the late summer and winter periods are highly variable (0-0.004 cu m/s/sq km). The temporal and spatial variation of these hydrologic characteristics reflects the combined influences of climate, physiography and vegetation. Frequently, streamflow characteristics between two adjacent watersheds are similar and closely correlated. Therefore, for ungauged watersheds, data from nearby gauged watersheds can be used with results from regionalization studies and supplementary short-term measurements to provide estimates for general water resource planning and design purposes. The coverage of hydrometric and climatic stations appears adequate for defining hydrologic characteristics in the basin. However, some improvements can be made by adding a few stations at key high elevation locations. (See also W90-08822) (Author's abstract)
W90-08880

RECHARGE/DISCHARGE RELATIONSHIPS IN A COARSE-GRAINED ALLUVIAL AQUIFER.
IEP, Inc., Sandwich, MA.
W. R. Thompson, S. Makepeace, and W. W. Woessner.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 695-703, 6 fig, 10 ref.

Descriptors: *Alluvial aquifers, *Flow discharge, *Groundwater recharge, *Headwaters hydrology, *Surface-groundwater relations, Geohydrology, Groundwater budget, Hydrologic regime, Irrigation water, Jocko River, Montana, River flow, Seasonal variation, Water level fluctuations, Water table fluctuations.

Coarse-grained alluvial aquifers, displaying dramatic seasonal fluctuations in recharge are typical of Rocky Mountain intermontane basins. Widespread problems with declining water tables and management of instream flows has caused a re-evaluation of the traditional emphasis of managing surface water strictly for irrigation use. Conjunctive use management, however, requires an understanding of groundwater surface water interactions. The geohydrology of the Jocko River Basin of western Montana is evaluated to quantify the effects stream and irrigation recharge have on the underlying aquifer. A well inventory was developed, stream and ditch gaging performed, aquifer geometry determined, and aquifer parameters estimated. The groundwater system is unconfined and composed of highly transmissive sand, gravel, cobbles, and boulders. The water table fluctuates up to 30 feet, rising from April through June and then declining through March. The river and irrigation systems are principal sources of recharge. The river loses approximately 50% of its discharge over a three mile reach at the head of the fan. A valley wide system of irrigation ditches lose on an average approximately 6% of their discharge per mile. The extensive length of the ditches results in a recharge rate roughly comparable to that of the Jocko River. The redistribution of river flows via irrigation ditches has the most profound effect in areas not subject to river recharge, accentuating seasonal fluctuations in water levels. Protection of domestic, stock and municipal water supplies in the Jocko Valley and other intermontane basins requires managers to understand the geohydrology of these recharge sensitive basins prior to instituting changes in surface water management. (See also W90-08822) (Author's abstract)
W90-08892

GREAT CLIMATIC MOVEMENTS (LES GRANDS MOUVEMENTS CLIMATIQUES).
J. Jacquet.
Houille Blanche HOBLAB, Vol. 1990, No. 1, p 19-42, 1990. 28 fig, 2 tab, 14 ref. English summary.

Descriptors: *Climatic changes, *Climatic data, *Climatology, *Geologic time, *Global warming, *Paleohydrology, *Resources management, Deserts, Drought, Future planning, History.

One of the great scientific contributions of our era is the decoding of planetary 'archives' relative to climate; successive cold and hot, humid and dry periods over more than a million years. Excellent quantified descriptions of the last cycles covering a period of 150,000 years, are now available. The explanation of these phenomena of the past, both their rhythm and their amplitude, remains an open question just as does the impact of human activities for the future. Understanding and simulation of past fluctuations will enable questions about the future to be answered with more precision. The corresponding research effort is a vital part of the Geosphere-Biosphere program, which will cover the decade of the 1990s and from which much is to be expected more responsible management of planetary resources. The relatively stable climatic conditions that we have been experiencing during the historic era only account for a moment in time in an actively-changing process. Drought phenomena and desertification must be interpreted relative to very diverse time scales, the long term being equal to about 20,000 years (the last climatic cycle) and the short term about one century (on the scale of anthropic factors). (Author's abstract)
W90-09056

CONFERENCE ON CLIMATE AND WATER. VOLUME 2.
September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. 393 p.

Descriptors: *Climatic changes, *Climatology, *Conferences, *Environmental impact, *Global warming, *Greenhouse effect, *Hydrologic systems, *Meteorology, Aquatic environment, Coastal zone management, Drainage, Energy sources, Flooding, Industrial water, Irrigation, Land management, Water resources management, Water supply.

The World Meteorological Organization convened a Conference on Climate and Water in Helsinki, Finland, from September 11-15, 1989. The second volume of the proceedings focuses on impacts of climatic variability and change resulting from the changes in hydrological variables. These impacts are discussed in terms of aquatic and terrestrial environments, coastal zones and navigation, urban and industrial water supply and drainage, energy production, anthropogenic influences, flood potential, and irrigation and land drainage. (See W90-09089 thru W90-09112) (Fish-PTT)
W90-09088

IMPACT OF CLIMATIC CHANGE ON THE AQUATIC ENVIRONMENT.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2B.
W90-09089

LONG-TERM CHANGES OF AQUATIC ECO-SYSTEM PARAMETERS IN RELATION TO CLIMATIC VARIATIONS.
Akademie der Wissenschaften der DDR, Berlin.
Inst. fuer Geographie und Geooekologie.
For primary bibliographic entry see Field 2B.
W90-09091

CLIMATE INDUCED HYDROLOGICAL SHIFTS IN EUROPE AND THEIR IMPLICATION SPECTRUM--UNIQUE OPPORTUNITY TO STRENGTHEN HYDROLOGY.
Swedish Natural Science Research Council, Stockholm.
For primary bibliographic entry see Field 2B.
W90-09092

VEGETATION, WATER, AND CLIMATIC CHANGE.
Akademiya Nauk SSSR, Moscow. Inst. Geografii.
A. F. Mandych.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 68-78, 4 fig, 18 ref.

Descriptors: *Climatic changes, *Climatology, *Global warming, *Greenhouse effect, *Rainfall-runoff relationships, *Soil-water-plant relationships, *Vegetation effects, Atmospheric chemistry, Carbon dioxide, Ecosystems, Erosion, Phytotoxicity, Temperature effects.

The forthcoming climatic changes due to increase of concentrations in the atmosphere of carbon dioxide and other greenhouse gases will be noticed in many climatic parameters. With climatic change, transformation of the vegetation cover will not be due only to increase or decrease of bioclimatic temperatures, but mostly due to modification of the relationships in the system: atmosphere-vegetation-soil-water. The forthcoming rapid climatic change resulting from the greenhouse effect would activate the hydrological processes with characteristic time significantly less than the time of natural evolution of soils and vegetation cover. Of these processes, the leading one would be the erosion-induced transformation of the soil cover. To foresee the probable changes in vegetation, it is very important to study the relationships of water with other components of landscapes in the ecotone zones at boundaries of the zonal biomes. It may be supposed that the leading factor deciding stability of their boundaries is the water regime of phytocenoses. (See also W90-09088) (Fish-PTT)
W90-09093

COMPLEX MODEL FOR ENVIRONMENTAL QUALIFYING.
Budapesti Mueszaki Egyetem (Hungary). Inst. of Water Management.
For primary bibliographic entry see Field 2B.
W90-09094

EXAMINATION OF RUNOFF AND LOSS OF SOIL IN FIELD EXPERIMENTS WITH SPECIAL REFERENCE TO PRECIPITATION.
Lajos Kossuth Univ., Debrecen (Hungary). Inst. of Geography.
A. Kerenyi.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 89-99, 2 fig, 3 tab, 1 ref.

Descriptors: *Climatic changes, *Erosion, *Parametric hydrology, *Rainfall impact, *Rainfall-runoff relationships, *Soil erosion, Correlation coefficient, Load distribution, Precipitation, Surface runoff, Vegetation effects.

Surface runoff, loss of soil, and concentration of load were measured in four experimental plots from spring to autumn for a period of three years. The measurements were primarily focused on the quantity, intensity (average intensity, 20-minute and 30-minute maximum intensity), drop energy, and the specific drop power of precipitation. The experiments were performed in three different stages. In the first stage the plots remained bare; in the second two of the plots were covered with plastic nets; while in the third stage the measurements were carried out in four different combinations: in a bare control plot, in a plot covered with nets, in one overgrown with vegetation, and, finally, in a plot covered with both a net and vegetation. It was found that specific drop power has a decisive role in the production of load. The relationship between the various rain parameters and initial erosion was determined by means of correlation calculation. The highest correlation coefficients were obtained in the case of the 20-minute maximum intensity and specific drop power variant. It was also demonstrated that, in the case of rain following dry spells, surface runoff diminishes while the water's load concentration increases. (See also W90-09088) (Author's abstract)

W90-09095

NON-POINT SOURCE POLLUTION FROM IRRIGATED WATERSHEDS: AN ASSESSMENT AND MANAGEMENT WITH REGARD TO CLIMATIC CHANGES.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
T. Belyaeva.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 100-113, 4 fig, 2 tab, 13 ref.

Descriptors: *Agricultural runoff, *Climatic changes, *Climatology, *Irrigation effects, *Non-point pollution sources, *Rainfall-runoff relationships, *Water quality control, Agricultural watersheds, Economic aspects, Evapotranspiration, Land resources, Land use, Optimization, Pollution load, Precipitation, Water quality standards, Water resources development.

An assessment of irrigation impacts on water quality with regard to alternative economic development strategies is considered as part of the general problem of regional water and land resources management under changing climate. The assessment of irrigation pollution consists of several stages: an assessment of unit loads of pollutants from agricultural watersheds according to land use type taking into account varied levels of precipitation, evapotranspiration, and runoff under considered climatic scenarios and economic development strategies implementing optimization modeling techniques for land and water resources allocation in the agricultural sector; conservation management of water and land resources use and pollution control according to established environmental constraints. The final stage is an iterative process aimed at reaching established water quality standards by means of land and water resources reallocation, technological shifts in crop production and irrigation methods. A comparative analysis of various strategies of economic development in an irrigated region (the Northern Caucasus area of the European Soviet Union) helped to select the optimal methods of production, technological, and environmental target achievement with regard to future global and regional climatic changes. (See also W90-09088) (Author's abstract)
W90-09096

IMPACTS OF CLIMATIC CHANGES ON HYDROLOGY AND WATER RESOURCES OF COASTAL ZONES.
IHP-National Committee, 106 Westlaan, 2641 DP Pijnacker, The Netherlands.
A. Volker.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 114-127, 5 fig.

Descriptors: *Climatic changes, *Climatology, *Coastal zone management, *Environmental impact, *Global warming, *Greenhouse effect, *Hydrologic cycle, *Sea level, *Water resources management, Catchment areas, Coastal marshes, Coasts, Deltas, England, Floods, France, Hydrologic properties, Lagoons, Morphology, Poland, Romania, Spain, The Netherlands, Water supply, West Germany.

Low-lying coastal areas such as deltaic and lagoon areas and coastal marshes are impacted by climatic changes on the hydrology and water resources of these coastal zones. While there exists an almost unanimous opinion about a forthcoming rise of the global air temperature there is less certainty about the effect of this rise on the sea level, largely due to the shortcomings of the simulation models relating atmospheric circulation with the oceanic and land cycles. Changes in the supply of fresh water to a delta resulting from climatic changes in the catchment affect in several ways the hydrology and morphology of the delta. Hydrological changes include: changes in the low flow regime; the frequency and magnitude of peak flows, flood volumes, the duration of the floods, and the season of occurrence; the dynamic equilibrium between

the forces of the river and the sea and any change in the sediment regime of the river; and human intervention in the physiographic conditions of the catchments. Morphological changes include: the dynamic equilibrium between construction and destructional forces; dune coasts; and shoals. A rise in sea level will affect the propagation of astronomical tides, storm surges, and sea water intrusion in open estuaries. Changes in the estuarine and river channel systems will impact the water management of the land areas of the delta. The choice of strategies to counteract the impacts of a rise in sea level depends on socio-economic, political, and psychological factors. Affected landscapes in Europe include the deltas of Poland, the Netherlands, Spain, France, and Romania, and low-lying areas of Denmark, England, West Germany, and France. (See also W90-09088) (Fish-PTT)
W90-09097

IMPACT OF SEA LEVEL RISE ON COASTAL ZONE MANAGEMENT IN SOUTHERN SWEDEN.
Lund Univ. (Sweden). Dept. of Water Resources Engineering.
G. Lindh, H. Hanson, and M. Larson.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 128-147, 8 fig, 30 ref.

Descriptors: *Climatic changes, *Climatology, *Coastal zone management, *Global warming, *Greenhouse effect, *Saline water intrusion, *Sea level, *Sweden, *Water resources management, Artificial recharge, Beach erosion, Breakwaters, Coasts, Erosion, Planning, Wells.

One consequence of the greenhouse effect is sea level rise. It is expected that this phenomenon will increase erosion along coastal reaches used for recreation as well as increase saltwater intrusion affecting water supply from wells located near the coast. These two problems may in the long run create a renewed attitude to long-term planning, development, and decision-making both on a local and regional level. Regions in southern Sweden would be affected by beach erosion and saltwater intrusion caused by sea level rise. Remedial measures in order to meet an increased erosion include: seawalls, groins, detached breakwaters, and artificial beach nourishment. Approaches to deal with the effects of saltwater intrusion include increasing flow in a water course, or installation of additional wells near the coast to create a freshwater barrier through artificial recharge. It is difficult to give recommendations about the most appropriate method to be used, since the consequences of the greenhouse effect will appear gradually at a rather slow rate. However, it is very important to create an awareness among people involved in coastal zone planning and management of coming climatic changes and its possible impacts. (See also W90-09088) (Fish-PTT)
W90-09098

IMPACT OF CLIMATE CHANGE ON COASTAL ZONE MANAGEMENT IN BRITAIN: A PRELIMINARY ANALYSIS.
Middlesex Polytechnic, London (England). Flood Hazard Research Centre.
A. M. Coker, P. M. Thompson, D. I. Smith, and E. C. Penning-Rowsell.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 148-160, 5 fig, 20 ref.

Descriptors: *Climatic changes, *Climatology, *Coastal zone management, *Future planning, *Global warming, *Greenhouse effect, *Sea level, *Water resources management, Beach erosion, Economic aspects, England, Environmental policy, Flooding, Planning, Storm surges, Water policy.

The impact of climate change on coastal zone resources and management in Britain could be profound. Recent research and analysis indicates that the extent of areas affected could be substantial, although the uncertainty in these predictions

remains large. The latest of these predictions estimate a rate of rise from 4 to 12 mm/year, with progressive increase over time. If such forecasts are correct the most noticeable and damaging effects of sea level change in Britain will be from the increased frequency of extreme events, such as storm surge, flooding, and erosion losses. The problem of sea level rise has three major components: the scientific assessment of magnitude, timing and rates; the impacts; and the policy options. There is general agreement among scientists on the former; however, studies of impact are crude and there are no agreed methodologies. The coastal management policy options for sea level rise can be succinctly expressed as do nothing, planned retreat, or protect. Further strategies are to lessen the level of protection and/or provide improved warnings for sea inundation. An adaptive approach would allow orderly adjustments to be made in response to a slow rise in sea level, but this strategy makes assumptions that could result in economic inefficiencies if long term implications are not considered. A current policy dilemma is that many coastal protection schemes have lives of 50-100 years. There is a need to construct these so that future options remain as open as possible. Major needs are for studies of future impacts--direct, indirect, and intangible--in order to provide an integrated framework for policy development. (See also W90-09088) (Fish-PTT)
W90-09099

IMPACTS OF CLIMATE VARIABILITY AND CHANGE ON URBAN AND INDUSTRIAL WATER SUPPLY AND WASTEWATER DISPOSAL.
International Inst. for Applied Systems Analysis, Laxenburg (Austria).
Z. Kaczmarek, and J. Kindler.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 161-176, 17 ref.

Descriptors: *Climatic changes, *Climatology, *Future planning, *Global warming, *Greenhouse effect, *Planning, *Wastewater disposal, *Water availability, *Water resources management, *Water supply development, *Water yield, Europe, Evapotranspiration, Industrial water, Precipitation, River basins, Runoff, Soil water.

Many economic, social, environmental, and climatic factors influence urban and industrial water supply as well as wastewater disposal conditions. The stability of climate and hydrology is a central concept in water resources planning. Since the mid-seventies scientists and, unfortunately, to a lesser extent, decision makers have agreed that it is no longer correct to assume that future water supply will be much like the past. Water managers have to use the new hydrologic estimates to evaluate the performance of water resource systems under changing climatic conditions. Climate affects water resources most directly in terms of precipitation. Temperature affects water availability through the process of evapotranspiration. Some forms of transfer function relating climate parameters, soil moisture, evapotranspiration, and runoff are needed to understand the effects of climate change on hydrology. The amount of warming caused by increasing concentrations of greenhouse gases is expected to be greater in the mid-latitude regions of Europe than the global average warming. The changes in climatic variables would generally be for the worse and not for the better of water resources management in Europe. There is some question as to whether climatologists will be able to expand their knowledge of the climate system fast enough to be able, in a short span of time, to identify possible impacts spatially and by season for specific river basins. Policy makers are reluctant to make major adjustments in the design of urban and industrial water supply and wastewater disposal systems to avert a distant and uncertain hazard. In spite of still existing uncertainties in climate predictions there is a need for new approaches to water resources planning to make supply systems more resilient and robust. (See also W90-09088) (Author's abstract)
W90-09100

IDENTIFYING THE CLIMATE-SENSITIVE SEGMENT OF BRITISH RESERVOIR YIELD.
Institute of Hydrology, Wallingford (England). Engineering Hydrology Div.
F. M. Law.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 177-190, 2 fig, 2 tab, 12 ref.

Descriptors: *Climatic changes, *Climatology, *Planning, *Rainfall-runoff relationships, *Reservoir yield, *Storage requirements, *Water yield, *Watershed management, Drought effects, England, Evapotranspiration, Future planning, Precipitation, Reservoir balance, Reservoir storage, Water yield improvement, Yield equations.

The role of a reservoir is to balance flows over a drought period using storage to cover cumulative deficits in meeting demand. Those flows originate from both prior climate as baseflow and from current climate as rapid response runoff. Recognizing the relative contribution of each segment of yield gives a fundamental understanding that can be used to determine the scope that climate change has to vary with yield. British conditions provide a useful example because of the range of reservoir types and ages, catchment geology, mean unit rainfall, dry season start dates and critical drought durations. The dominant UK water supply yield estimation method concentrates on the total drought flow that can be relied on for a chosen level of risk (normally the once-in-fifty year event). Results from such analyses are best compared using dimensionless yield-storage 'curves' and noting on them the critical drought durations that have determined each straight line sector of those curves. At high levels of regulation when the gross yield is perhaps 90% of mean flow then the crucial climatic elements are mean rainfall and mean actual evapotranspiration. As 35-year mean rainfall in the wetter areas of Britain has been known to vary by up to 14% between two adjacent independent periods (1881-1915/1916-50), it is necessary to take a very long term view at such reservoirs. Conversely, a storage that is small relative to the catchment and with a low level of regulation will be dependent either on baseflows or solely on storage spanning an intense drought of a few weeks duration. In such cases the importance of climate variation lies not in the magnitude of rainfall or evaporation but in the duration of dry spells. (See also W90-09088) (Author's abstract)
W90-09101

IMPACT OF 'GREENHOUSE EFFECT' ON SEWERAGE SYSTEMS.
Lund Univ. (Sweden). Dept. of Water Resources Engineering.
J. Niemczynowicz.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 191-206, 3 fig, 3 tab, 22 ref.

Descriptors: *Climatic changes, *Global warming, *Greenhouse effect, *Planning, *Sewer systems, *Storm wastewater, *Urban runoff, *Wastewater facilities, Finland, Future planning, Hydrologic cycle, Rainfall-runoff relationships, Rural areas, Urban areas.

The possible impacts of modification in rainfall patterns due to greenhouse effect on the function of the sewage system was studied based on a case study of the cities of Lund (urban) and Malmo (rural), Finland. The Storm Water Management Model was used to simulate changes in runoff pattern, assuming 10%, 20%, and 30% levels of rainfall increase. Possible effects of increase in rainfall intensity on the urban water cycle include further decreases of storage capacity and enhanced runoff, causing increased leakages to sewage system conduits, and resulting in environmental, economic, and legal consequences. Preventive measures that can be taken are to construct new conduits and to increase the capacity of the sewage treatment plants. The city of Malmo, in spite of the fact that the sewage system has been especially adapted to lowland conditions, is very vulnerable

to changes in sea level and increasing precipitation. Given examples of possible impacts of the greenhouse effect on the functioning of the sewage system, in spite of considerable uncertainty regarding the potential future rate of hydrological changes, these systems are very vulnerable to results of climate changes. Further studies should be aimed at increasing recognition and understanding of future problems, facing the high probability that future climate changes will really occur. Investigations of impacts on other cities should be performed. (See also W90-09088) (Fish-PTT)
W90-09102

CHANGES OF WATER RESOURCES (ABOUT WATER MANAGEMENT OF HUNGARY).
Ministry of Environment and Water Management, Budapest (Hungary).
L. S. Nagy.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 207-236, 7 fig.

Descriptors: *Climatic changes, *Climatology, *Drought, *Global warming, *Greenhouse effect, *Hungary, *International waters, *Rainfall-runoff relationships, *Surface water, *Water management, *Water quality control, *Water resources management, *Water supply development, *Zambia, Available water, Boreholes, Data acquisition, Environmental protection, Governmental interrelations, Hydrologic cycle, International agreements, Monitoring, Regression analysis, Reservoirs, River flow, Water pollution control, Well water.

There are not enough cheap and clean water sources for utilization, so more effort is needed to manage water with new reservoirs, dams, wastewater treatment, levee systems, etc. Most of this construction needs more effective international cooperation. International watersheds are increasingly transcending political borders. Transboundary pollution needs more coordinated observation by modern monitoring systems and planning of routine and emergency management actions. Hungarian water management has necessarily grown in importance because of the increasing demands for water and the scarcity, especially in the summer dry period, of available water resources. Increasing pollution has faced water management with the difficult task of protecting both surface and groundwater quality. Hungary has bilateral water agreements with all neighboring countries, and water management problems can only be solved in close cooperation with these countries. The natural hydrological cycle is changing, due to the development of civilization and the greenhouse effect, and scientists must be aware of the trends of change to protect people and the environment. A surface and groundwater observation network, with processing, registration, and publication of data, has been in existence since 1876, but needs to be updated with current computer technology. The National Master Plan of Water Management covers the basic goals of water management, the overall tasks of its development, and the necessary basic natural and social information for the whole domain of the country's water management. Structural and forecasting system improvement is necessary for protection against natural hazards (floods, drought). Hungary's public information and education programs are considered to be very important and are effective. (See also W90-09088) (Fish-PTT)
W90-09103

GLOBAL CLIMATIC CHANGE: IMPLICATIONS FOR ENERGY POLICY.
Minnesota Univ., Minneapolis. Hubert H. Humphrey Inst. of Public Affairs.
D. Abrahamson, and T. B. Johansson.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 245-274, 3 fig, 7 tab, 61 ref.

Descriptors: *Climatic changes, *Climatology, *Energy, *Energy sources, *Global warming, *Greenhouse effect, Economic development, Energy conversion, Environmental policy, Nuclear energy.

Greenhouse heating resulting from emissions of radiatively active gases will, if unchecked, result in rapidly increasing global temperatures. Global climatic change will heavily impact the energy sector: (1) existing energy systems will be affected by changes in temperature, precipitation, river flows, and temperature-sensitive energy demands; and (2) the energy supply system will be much more affected by measures to limit climatic change. To formulate strategies to limit climatic change requires the simultaneous consideration of other criteria such as the need to provide for world-wide economic development, global security implications of dependence on Persian Gulf oil and large-scale nuclear power, and environmental restrictions. The two key strategies are effective use of energy and the use of renewable energy sources. Technologies are available to reduce energy consumption in industrialized countries by at least 50% without loss of energy services and meeting the usual tests of economic efficiency. Photovoltaic systems suitable for small-scale and large-scale applications are on the near horizon, as are advanced fuel cells and advanced gas turbines which may be coupled with biomass gasification plants. Energy conservation and renewable energy supplies are no longer optional, they are now required if climate change is to be limited. (See also W90-09088) (Author's abstract)
W90-09105

IMPACT OF CLIMATE ON THE OPERATION OF THE FRENCH ELECTRIC SYSTEM.
Electricite de France, Grenoble.
For primary bibliographic entry see Field 2B.
W90-09106

ENVIRONMENTAL IMPACT ON CLIMATE DUE TO MANMADE RESERVOIRS.
Centro di Ricerca Idraulica e Strutturale, Milan (Italy).
G. Rossi.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 290-309, 15 fig, 6 tab, 12 ref.

Descriptors: *Climatic changes, *Dam effects, *Energy sources, *Environmental impact, *Hydroelectric power, *Reservoirs, Available water, Climatic data, Evaporation, Evapotranspiration.

The impact on the environment due to the building and the management of a hydroelectric reservoir covers many aspects ranging from human and social to hydrologic, agricultural and climatic ones. The overall parameters that may represent both the climatic regime and the vegetation fitness are evaporation and evapotranspiration; they are the keystones of the feedback processes involving the lower atmosphere layer, solar energy fluxes, and transpiration strength. The method adopted to calculate evapotranspiration, usually on a monthly scale, was derived from the complementary relationship which relates regional and potential evapotranspiration with regional evapotranspiration in saturated conditions, through an index depending on the water availability. By this procedure it is possible to make up climatic indexes involving both evapotranspiration and evaporation. The problem of the evaluation of the environmental impact may be approached by two strategies depending on climatological data availability: (1) historical series, if climatological data has been recorded over a long period before the reservoir is put into operation; and (2) witness basin, when climatological data are available only after the reservoir has started operating, gathering data both from the basin under control and from a witness basin, in the neighborhood of the controlled basin but not influenced by the reservoir, presumed to have the same regional evapotranspiration. The impact on the environment may be evaluated by analyzing the trend of such indexes before and after the reservoir operation, following the first strategy, and by comparing the two sets of the indexes calculated for the same period, the second strategy. (See also W90-09088) (Author's abstract)
W90-09107

ANTHROPOGENIC CHANGES OF CLIMATE, WATER RESOURCES AND WATER MANAGEMENT PROBLEMS.
Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR).
I. A. Shiklomanov.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 310-347, 2 fig, 4 tab, 43 ref.

Descriptors: *Climatic changes, *Climatology, *Future planning, *Global warming, *Greenhouse effect, *Hydrologic cycle, *Planning, *Water resources management, Analytical methods, Discharge, Europe, Hydrological regime, Model studies, North America, Precipitation, River flow, Salt balance, Seasonal variation, Soil water, Soviet Union, Stream discharge, Streamflow, Water supply.

The predicted anthropogenic changes of climate for the last 40 to 60 years, corresponding to a rise of mean global air temperature of 3-4 C, are so important for moderate and higher latitudes of the Northern Hemisphere in particular, that it is quite evident that they would affect natural conditions in vast regions and in different countries as a whole. The importance of the problem is shown in the study of the hydrological cycle as affected by changes of the global climate, which causes higher concentrations of greenhouse gases in the atmosphere. Different methodological approaches are applied in different countries (long-term variations of runoff, water balance methods, general circulation models, and deterministic models), with basic data and prerequisites used by different scientists to evaluate and predict the effect of climatic changes on water resources and on hydrological regime. North America and Western Europe were evaluated using all of the methodological approaches, and show a continuous decrease of soil moisture content in summer, a great decrease of summer discharges and great increase of winter discharges, and transformation of streamflow distribution during the year. Long-term water balance method evaluations in the USSR concluded that most unfavorable water resources changes should be expected in forest-steppe zones, and much more annual precipitation can be expected over the whole region. The effect of the expected climatic changes on water supply, control and water transfers are closely connected with the problems of water level regime, water and salt balances of the largest inland water bodies of the world. (See also W90-09088) (Author's abstract)
W90-09108

FLOOD POTENTIAL, AN UNCERTAIN ESTIMATE RESULTING FROM CLIMATIC VARIABILITY AND CHANGE.
Hydrographisches Zentralbuero, Vienna (Austria).
F. Nobilis.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 348-356, 29 ref.

Descriptors: *Climatic changes, *Climatology, *Flood forecasting, *Global warming, *Greenhouse effect, *Rainfall-runoff relationships, *Water resources management, Environmental impact, Hydrologic models, Model studies, Precipitation, Time series analysis.

A recent study of the implications of climatic variability and climate change for the planning and management of US resources stresses that global warming will cause wide geographical variations in precipitation which could change flood potential. Flood potential investigations were performed on rainfall-runoff relationships in various regions of the US. There are only a few quantitative results; the present model properties are not apt to give regionally limited information. The main necessities in assessment of flood potential due to climate variability and change are: (1) to differentiate natural and man-made impacts, (2) to analyze spatially well-distributed long time series of relevant parameters, (3) to improve general circulation models for regional applicability, (4) to use reason-

able scenarios, and (5) to improve hydrological models combined with climate scenarios. The work being done is only a first step for the realistic evaluation of decreasing or increasing flood potential. This uncertainty could be reduced by hydrologists within the next few years. It will be necessary to intensify research efforts because of the potential danger for man and the financial effects. (See also W90-09088) (Fish-PTT)
W90-09109

IMPACT OF CLIMATE VARIABILITY AND CHANGE ON WATER RESOURCES MANAGEMENT IN AGRICULTURE.
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Geographisches Inst.
For primary bibliographic entry see Field 2B.
W90-09110

STUDY OF WATER RESOURCES SYSTEMS OPERATION TAKING ACCOUNT OF CLIMATIC CHANGES.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
V. M. Shnaidman.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 383-393, 9 ref.

Descriptors: *Agricultural water, *Climatic changes, *Climatology, *Global warming, *Greenhouse effect, *Irrigation programs, *Rainfall-runoff relationships, *Water demand, *Water resources management, Carbon dioxide, Model studies, Simulation analysis, Water supply.

Global warming of the climate entails changes in the characteristics of natural processes, caused by the increase in atmospheric CO2 content. It affects river runoff parameters and moisture indices for vast areas which, in turn, entails modification of water resources system (WRS) operation and therefore of the reliability of water supply. Quantitative evaluation of these changes, using WRS modeling and the implementation of measurements can give positive results for national economies. A method based on the investigation of water resources system sensitivity using a simulation model is suggested to estimate the operation of irrigational WRS. The solution of the problem includes: development of stochastic models of river runoff and irrigational water consumption; determination of permissible ranges of variations in the main characteristics of simulated processes using different climate scenarios and expert's evaluations; obtaining stochastic realizations of river runoff and irrigational water demands under fixed characteristics of input processes, implementation of simulation experiments; calculation of WRS operation indices; modification of input processes characteristics within the assigned interval; and evaluation of WRS sensitivity. (See also W90-09088) (Fish-PTT)
W90-09112

PERIODIC COVARIANCE STATIONARITY OF MULTIVARIATE PERIODIC AUTOREGRESSIVE MOVING AVERAGE PROCESSES.
Middle East Technical Univ., Ankara (Turkey). Dept. of Statistics.
For primary bibliographic entry see Field 7C.
W90-09160

R-5 REVISITED: II. REEVALUATION OF A QUASI-PHYSICALLY BASED RAINFALL-RUNOFF MODEL WITH SUPPLEMENTAL INFORMATION.
California Univ., Berkeley. Dept. of Soil Science.
K. Loague.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 973-987, May 1990. 6 fig, 13 tab, 34 ref.

Descriptors: *Infiltration, *Model studies, *Rainfall-runoff relationships, *Runoff, *Soil water, Catchment areas, Horton overland flow mechanism, Mathematical studies, Overland flow, Pastures, R-5 catchment site, Simulation analysis, Watersheds.

Application of a new set of infiltration data for the 0.1 sq km R-5 experimental site, Chickasha, Oklahoma did not produce an overwhelming improvement in performance of the quasi-physically based rainfall-runoff model. This model, an event-based simulator of the Horton overland flow mechanism, did not fully approximate the rainfall-runoff processes for the catchment, which has a combination of Horton and Dunne overland flow. (See also W90-09169) (Cassar-PTT)
W90-09170

CHANGING RAINFALL-RUNOFF RELATIONSHIPS IN THE URBANIZING PEACHTREE CREEK WATERSHED, ATLANTA, GEORGIA.
Georgia Univ., Athens. School of Environmental Design.
For primary bibliographic entry see Field 4C.
W90-09355

GROUND WATER FLOW AND RUNOFF IN A COASTAL PLAIN STREAM.
South Carolina State Coll., Orangeburg. Dept. of Natural Sciences.
J. B. Williams, and J. E. Pinder.
Water Resources Bulletin WARBAQ, Vol. 26, No. 2, p 343-352, April 1990. 5 fig, 2 tab, 14 ref.

Descriptors: *Aquifers, *Base flow, *Coastal streams, *Groundwater movement, *South Carolina, *Surface-groundwater relations, Headwaters, Hydrographs, Seasonal variation, Seepage, Streamflow.

The quantity, seasonality, and sources of flow were analyzed for two segments of Four Mile Branch, a small stream on the Coastal Plain of South Carolina using data obtained from USGS gaging stations. Flows in the 'upstream segment', a 12.6-sq km watershed comprising the head waters of Four Mile Branch, averaged 0.129 cu m/s and showed a distinctly seasonal pattern, with maximum flows in February and March and minimum flows in September and October. Inflow to the 'downstream segment', a 2.2-sq km watershed associated with the main channel, averaged 0.059 cu m/s and showed no seasonal patterns. Discharges per unit area of watershed were greater for the downstream segment, 0.83 cu m/yr/sq m of land surface, than for the upstream segment, 0.32 cu m/yr/sq m. The differences in discharge rates and seasonalities between the two segments reflect differences in aquifers supplying the different segments. Analyses of streamflow by hydrograph separation and streamflow partitioning methods indicated that > 90 % of the flows in the upstream and downstream segments were due to groundwater-driven base flows. (Author's abstract)
W90-09358

CONTRIBUTION OF ACIDIC DEPOSITION ON HIGH ELEVATION FOREST CANOPY TO THE HYDROLOGIC CYCLE.
North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.
For primary bibliographic entry see Field 5B.
W90-09430

MIXING OF ACID MELTWATER WITH GROUNDWATER IN A FORESTED BASIN IN FINLAND.
Uppsala Univ. (Sweden). Dept. of Hydrology.
For primary bibliographic entry see Field 5B.
W90-09436

HYDROMETEOROLOGICAL CHARACTERISTICS OF THE TIBET PLATEAU.
Nanjing Hydrological Research Inst. (China).
G. Liu.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 267-280, 10 fig, 6 tab, 8 ref.

Descriptors: *Alpine regions, *Hydrologic budget, *Hydrometeorology, *Meteorology, *Tibet, Climates, Evaporation, Heat transfer, Precipitation, Runoff, Temperature, Water vapor.

The Tibet Plateau (Xizang Plateau) is the highest plateau in the world, with most of its area higher than 4000 m. It has a cold environment and is known as the third polar cap of the Earth. The Plateau is surrounded by mountains with high ridges and is characterized by a high terrain, cold climate, strong sunshine, low humidity, deep mountain valleys, a bare underlying surface, and a fragmental topography. All these geographical features result in a distinct hydrologic regime for the Plateau. The entire Plateau transfers heat to the surrounding air at a rate of 1.1 times 10 to the 18th power kcal/day. During May to August, the increase in temperature is much higher on the Tibet Plateau than in the middle-lower regions of the Yangtze River Valley. The effect of heating the air column above the plateau causes a convergence of air in the bottom layer the column (lower than 600 hPa) so that a vertical circulation of air is formed. Associated with this airflow cycle, water vapor also converges at the bottom and diverges at the top. The difference between the convergence and divergence of water vapor accounts for the net influx of water vapor in the air above the plateau, which maintains its air moisture and supports the precipitation, evaporation and runoff of the plateau. The average annual net influx of water vapor over the Tibet Plateau is 373.1 mm, annual precipitation is 593.7 mm and annual evaporation is 220.6 mm, while annual runoff is 373.1 mm. This indicates that the total annual precipitation is about 119 times more than the moisture in the atmosphere and 1.6 times more than the net influx of water vapor, which indicates the active cycle of water on the Tibet Plateau. (See also W90-09408) (Lantz-PTT)
W90-09438

METHODOLOGY FOR LOCATING AND MEASURING SUBMERGED DISCHARGES: TARGETING TOOL, HARPOON PIEZOMETER AND MORE.
Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
For primary bibliographic entry see Field 7B.
W90-09480

COMPARISON OF METHODS FOR ESTIMATING GROUNDWATER RECHARGE FROM A LAKE.
Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
For primary bibliographic entry see Field 2F.
W90-09482

DETERMINING THE AREA OF CONTRIBUTION TO A WELL FIELD: A CASE STUDY AND METHODOLOGY FOR WELLHEAD PROTECTION.
BCI Geonetics, Inc., Laconia, NH.
For primary bibliographic entry see Field 4B.
W90-09504

2B. Precipitation

URBAN STORM WATER TRANSPORT AND WASH-OFF OF CESIUM-137 AFTER THE CHERNOBYL ACCIDENT.
Uppsala Univ. (Sweden). Dept. of Hydrology.
For primary bibliographic entry see Field 5B.
W90-08690

CLOUD SEEDING, DATA COLLECTION AND ANALYSIS ASSOCIATED WITH THE COLORADO RIVER AUGMENTATION DEMONSTRATION PROGRAM, 1985-86 SEASON.
North American Weather Consultants, Salt Lake City, UT.
For primary bibliographic entry see Field 3B.
W90-08754

Group 2B—Precipitation

REPORT OF THE SCIENCE STEERING GROUP FOR A TROPICAL RAINFALL MEASURING MISSION (TRMM).
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
For primary bibliographic entry see Field 7B.
W90-08763

GLOBAL SNOW DEPTH CLIMATOLOGY.
Air Force Environmental Technical Applications Center, Scott AFB, IL.
For primary bibliographic entry see Field 2C.
W90-08765

SEASONAL SNOWFALL STATISTICS FOR SELECTED STATIONS.
Air Force Environmental Technical Applications Center, Scott AFB, IL.
For primary bibliographic entry see Field 2C.
W90-08766

HYDROLOGIC PRODUCTION ZONES IN A HEADWATER WATERSHED.
Northeastern Forest Experiment Station, University Park, PA.
For primary bibliographic entry see Field 2E.
W90-08879

CONSTRUCTION AND CALIBRATION OF A RAINFALL SIMULATOR.
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).
N. P. Thomas, and S. A. El Swaify.
Journal of Agricultural Engineering Research JAERA2, Vol. 43, No. 1, p 1-9, May 1989. 8 fig, 2 tab, 11 ref.

Descriptors: *Erosion, *Instrumentation, *Rainfall simulators, *Rainfall-runoff relationships, *Simulated rainfall, Infiltration, Runoff.

A portable rainfall simulator featuring a rotating disc and nozzle, has been developed for use in field studies of erosion, infiltration, and runoff processes. Variable intensities of simulated rainfall ranging from 15 to 150 mm/hour are produced by choice of appropriate nozzles and slot apertures in the rotating disc. The duration of the simulation can be precisely controlled by a shutter mechanism. The measured uniformity coefficients ranged from 91.2 to 94.3%. The kinetic energy of the simulated rainfall at intensities above 30 mm/hour was close to that of natural rainfall. (Author's abstract)
W90-08903

SMALL AREA VARIABILITY OF WARM-SEASON PRECIPITATION IN A SEMIARID CLIMATE.
Agriculture Canada, Swift Current (Saskatchewan). Research Station.
B. G. McConkey, W. Nicholaichuk, and H. W. Cutforth.
Agricultural and Forest Meteorology AFMEEB, Vol. 49, No. 3, p 225-242, February 1990. 8 fig, 6 tab, 23 ref.

Descriptors: *Meteorology, *Precipitation, *Seasonal variation, *Spatial distribution, Canada, Climates, Plant growth, Rain gages, Semiarid climates.

The spatial variability of precipitation, as measured with standard rain gauges spaced 800-4400 m apart, was studied at Swift Current, Saskatchewan, Canada over a 34-year period. Spatial variability, relative to precipitation amount, was greater for small storms of less than 7.5 mm than for larger storms. The probability of the differences in measured precipitation for a storm exceeding a set amount increased approximately linearly with the separation distance between rain gauges although this trend weakened as the size of the difference increased. In several years, measured differences in cumulative precipitation during the growing season indicated important differences between rain gauge locations in growing conditions for spring-sown cereal crops. The probability of the measured difference in cumulative precipitation

during the growing season exceeding a set amount increased approximately linearly with the separation distance between rain gauges. Where knowledge of precipitation amount is very important for small-plot biological field experiments, precipitation should be measured at or within a few hundred meters of the experiment site. However, where monthly areal estimates of warm-season precipitation are required, there was little reason for gauging densities of less than 2.6 sq km/rain gauge. (Author's abstract)
W90-08927

HIGH-INTENSITY RAINFALL RATE DETERMINATION FROM TIPPING-BUCKET RAIN GAUGE DATA.
Agricultural Research Service, Florence, SC. Coastal Plains Soil and Water Conservation Research Center.
E. J. Sadler, and W. J. Busscher.
Agronomy Journal AGJOAT, Vol. 81, No. 6, p 930-934, November/December 1989. 4 fig, 3 tab, 10 ref.

Descriptors: *Erosion, *Instrumentation, *Rain gages, *Rainfall rate, *Runoff, Computer programs, Data interpretation, Regression analysis, Temporal variation.

Traditional techniques used to measure and record rainfall have produced even totals or hourly rates. These are unsuitable for studying short-term impacts in brief storms (e.g., 27 mm in 30 minutes). A study was undertaken to develop an analytical procedure to provide millimeter per minute resolution in rainfall rate from short-term, tipping-bucket, rain gauge data. The analytical procedure was written in FORTRAN and has hardware requirements within the capabilities of most desktop microcomputers. Counts of tips in one minute intervals were assembled into an array of accumulated rainfall over time during an event. A cubic spline was fitted to the accumulated rainfall curve and then differentiated to yield the rate curve. Four synthetic rainfall patterns were used to test the technique by matching original and reconstructed curves. Regression of reconstructed rates on input rates resulted in r-squared ranging from 0.989 to 0.996. When applied to field data from eight events (total: 209.5 mm) in July 1984 and six events (total: 139 mm) in July 1985, the technique described rainfall rate as a smooth, continuous function of time. This characteristic improves the suitability of the data for input to models of infiltration and runoff that adapt time steps to overcome numerical instability under rapidly changing conditions. (Author's abstract)
W90-08931

GREAT CLIMATIC MOVEMENTS (LES GRANDS MOUVEMENTS CLIMATIQUES).
For primary bibliographic entry see Field 2A.
W90-09056

CONFERENCE ON CLIMATE AND WATER. VOLUME 2.
For primary bibliographic entry see Field 2A.
W90-09088

IMPACT OF CLIMATIC CHANGE ON THE AQUATIC ENVIRONMENT.
Institute of Hydrology, Wallingford (England).
M. Beran.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 7-27, 35 ref.

Descriptors: *Aquatic environment, *Climatic changes, *Climatology, *Ecosystems, *Environmental impact, *Global warming, *Model studies, *Water quality, *Water yield, Biological properties, Chemical properties, Data acquisition, Hydrologic aspects, Hydrologic models, Physical properties, Public health, Waste disposal, Water chemistry, Water supply.

Climatic change has various effects on hydrological variables, i.e., the physical, chemical, and biological properties of water bodies; and has conse-

quences for water supply, waste disposal, health, and the viability of aquatic ecosystems. Rivers, lakes, bogs, marshes, tundra, and deltas respond to changes in climate and carbon dioxide. The term 'scenario' is used to describe a picture of the climatic future, often constructed by a General Circulation model, informing only how a system might reasonably be expected to behave under specified circumstances. Impact studies, empirical methods, instrumental methods, and spatial analogs are used. Some of the techniques that can be used to obtain information for a specific location and to construct a high resolution time series in conformity with grid square predictions (the climate inversion problem) include temporal adjustment, spatial infilling, and extreme values. The physical environment of water bodies includes water, heat, and sediment flux, as well as temperature, wind, and sediment load. Water chemistry will be influenced by the effect of temperature on chemical equilibrium and on reaction rates as well as through altered delivery of nutrients and solutes from upstream. Biological impacts are conveniently considered by means of the food chain from nutrients and bacteria, through plankton, to the higher trophic levels. Few authors have attempted to evaluate the impact of climatic change on qualitative aspects. Relevant impact and other studies by experts in water quality and aquatic ecology are encouraged. (See also W90-09088) (Fish-PTT)
W90-09089

IMPACT OF PRECIPITATION VARIABILITY ON THE QUALITY OF RUNNING WATERS.
Uppsala Univ. (Sweden). Dept. of Hydrology.
For primary bibliographic entry see Field 5B.
W90-09090

LONG-TERM CHANGES OF AQUATIC ECOSYSTEM PARAMETERS IN RELATION TO CLIMATIC VARIATIONS.
Akademie der Wissenschaften der DDR, Berlin. Inst. fuer Geographie und Geooekologie.
R. Stellmacher.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 37-42, 3 fig, 5 ref.

Descriptors: *Aquatic environment, *Climatic changes, *Climatology, *Statistical methods, *Time series analysis, Annual distribution, Discharge, Global warming, Periodicity, Seston, Spectral analysis.

The evolution of different ecological parameters in time and their relationship to climatic variables was evaluated. The structures of different series of annual values (discharge, buoyant part of seston, global radiation, dryness index), and their variabilities have been analyzed using applications of one-channel and two-channel autoregressive spectral estimation methods. It was found that a good correlation appears between seston and global radiation for the periodicity of about two years. Periods of about 5 and 15 years were significant concerning relations between seston and discharge. It seems that there exists a good coherence relation between discharge and dryness index, especially for periodicities of about 12 and 5 years. (See also W90-09088) (Fish-PTT)
W90-09091

CLIMATE INDUCED HYDROLOGICAL SHIFTS IN EUROPE AND THEIR IMPLICATION SPECTRUM--UNIQUE OPPORTUNITY TO STRENGTHEN HYDROLOGY.
Swedish Natural Science Research Council, Stockholm.
M. Falkenmark.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 43-67, 6 fig, 4 tab, 17 ref.

Descriptors: *Agriculture, *Climatic changes, *Europe, *Global warming, *Greenhouse effect, *Rainfall-runoff relationships, *Water demand, *Water management, Available water, Drought,

Freshwater, Hydrologic aspects, Hydrologic cycle, Marine biology, Research priorities, Vegetation effects, Water policy, Water stress.

Climate change is felt by society first through water-related phenomena. The wettening of European land may change considerably with wetter conditions in the North and drier in the South. Considerable growing period shifts may perturbe European agricultural patterns, increasing the growing season in the North but creating drought problems in the South. Water availability may became less in the South, causing large water management problems when higher demand from agriculture has to be met under increased water stress. Climate change implications for well-organized European societies should not be underestimated. Most sectors of society will feel changes, and have to meet increasing costs for adaptation measures. The result may include an all-time-high in the demand for hydrological consultancy. Timely policy responses will be crucial for adaptation of mitigation but will depend on the development of improved ways of communication between scientists and policy-makers. The organization of policy workshops, and the use of matrices to transfer messages on interdependent phenomena might be useful components. The considerable implications of the climate change, propagated through the water cycle, will create large research needs, particularly on the interaction water-soil-vegetation, water quality genesis changes, influence of hydrological shifts on land use, methods for early warning by use of hydrological indicator systems, and assessment of expected changes in the hydrology and freshwater exchange of the Baltic with secondary consequences on the marine biology of the system. Climate change will provide a unique opportunity to strengthen and renew hydrology, defending its position as one of the major geosciences. (See also W90-09088) (Author's abstract)
W90-09092

VEGETATION, WATER, AND CLIMATIC CHANGE.
Akademiya Nauk SSSR, Moscow. Inst. Geografii.
For primary bibliographic entry see Field 2A.
W90-09093

COMPLEX MODEL FOR ENVIRONMENTAL QUALIFYING.
Budapesti Mueszaki Egyetem (Hungary). Inst. of Water Management.
K. Koris.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 79-88, 1 fig, 7 ref.

Descriptors: *Climatic changes, *Climatology, *Environmental quality, *Hungary, *Mathematical models, *Model studies, *Rainfall-runoff relationships, Economic aspects, Environmental policy, Parametric hydrology, Social aspects, Water quality.

A quantitative characterization of the environmental situation is important for judging environmental quality, planning investments, or supporting environmental decisions. Such a quantitative qualification of the environment may play an important role even on a regional (e.g., European) scale, when evaluating the quality of the given region's environment or preparing regional strategies for environmental protection or signing pacts for regional protection of the environment. The Complex Model for Environmental Qualifying (CMEQ) describes the environment of a minor region in Hungary (the Zala River basin in 1982-1983) using a parameter system of water, air, and soil quality. Ecological/biological/social/economical components need to be added to the model in the future. The model is an approximate measure of the state of the environment, comparing the environment with similarly computed quality categories. If any of the quality parameters changes (e.g., the NOx emission of a country is reduced), the environmental quality changes as well, and the numerical value of this change can be expressed by the model. It may even be possible, after a suitable

modification of the model, to characterize regional climate changes quantitatively. (See also W90-09088) (Author's abstract)
W90-09094

EXAMINATION OF RUNOFF AND LOSS OF SOIL IN FIELD EXPERIMENTS WITH SPECIAL REFERENCE TO PRECIPITATION.
Lajos Kossuth Univ., Debrecen (Hungary). Inst. of Geography.
For primary bibliographic entry see Field 2A.
W90-09095

IMPACTS OF CLIMATIC CHANGES ON HYDROLOGY AND WATER RESOURCES OF COASTAL ZONES.
IHP-National Committee, 106 Westlaan, 2641 DP Pijnacker, The Netherlands.
For primary bibliographic entry see Field 2A.
W90-09097

IMPACT OF SEA LEVEL RISE ON COASTAL ZONE MANAGEMENT IN SOUTHERN SWEDEN.
Lund Univ. (Sweden). Dept. of Water Resources Engineering.
For primary bibliographic entry see Field 2A.
W90-09098

IMPACTS OF CLIMATE VARIABILITY AND CHANGE ON URBAN AND INDUSTRIAL WATER SUPPLY AND WASTEWATER DISPOSAL.
International Inst. for Applied Systems Analysis, Laxenburg (Austria).
For primary bibliographic entry see Field 2A.
W90-09100

IMPACT OF 'GREENHOUSE EFFECT' ON SEWERAGE SYSTEMS.
Lund Univ. (Sweden). Dept. of Water Resources Engineering.
For primary bibliographic entry see Field 2A.
W90-09102

EFFECTS OF CLIMATE VARIATION OF PUBLIC WATER SUPPLY.
Central Forecast Office, Lusaka (Zambia). Dept. of Meteorology.
W. S. Goma.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 237-244, 4 fig, 1 tab, 3 ref.

Descriptors: *Climatic change, *Climatology, *Drought, *Rainfall-runoff relationships, *Surface water, *Water resources management, *Water supply development, *Zambia, Boreholes, Monitoring, Regression analysis, Reservoirs, River flow, Well water.

In this decade there has been a heightened awareness in Zambia of the changing climate environment, in which both high and low rainfall amounts have been experienced. Weather and its fluctuation is the main concern of water resources management. Drought is a recurring phenomena but time between drought varies widely as does the duration and intensity of the drought itself. An assessment of the surface water is essential, as river water is generally the most useful and most amenable to rapid control. Rainfall figures for the past 50 years have been analyzed using regression analysis. It may be predicted that the 1990s will be wet years. The main sources of public water supply are from rivers, boreholes, and wells. It was shown that even during low rainfall periods, water production was not affected as water pumping was readjusted. Borehole water levels changed very little during a two-year monitoring period. An assess concluded that, weather fluctuations do not much affect the water supply from the main public reservoir. (See also W90-09088) (Fish-PTT)
W90-09104

GLOBAL CLIMATIC CHANGE: IMPLICATIONS FOR ENERGY POLICY.
Minnesota Univ., Minneapolis. Hubert H. Humphrey Inst. of Public Affairs.
For primary bibliographic entry see Field 2A.
W90-09105

IMPACT OF CLIMATE ON THE OPERATION OF THE FRENCH ELECTRIC SYSTEM.
Electricite de France, Grenoble.
D. Duband, P. Rabut, P. Clavel, and J. Leveugle.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 275-289, 9 fig, 3 tab.

Descriptors: *Climatic changes, *Climatology, *Decision making, *Electric power production, *Energy sources, *France, *Global warming, *Hydroelectric power, *Planning, Air temperature, Forecasting, Nuclear energy, Precipitation, Thermal energy.

Climatic conditions always play an important role in the decision-making processes of electrical power authorities, and this is especially true of the French electric system. In the past, climatic effects were mainly felt in the domain of hydroelectric power generation. However in recent years, with the structural evolution of power consumption, the growing predominance of nuclear power generation and the progress achieved in the modeling of the various phenomena involved, many complex problems related to the impact of climate on the operation of the electric system have been confronted and in many cases solved. Electricite de France (EDF) incorporates climatic parameters in solving three particular problems: (1) water resource management and streamflow forecasting, (2) energy consumption forecasting, and (3) the joint operation of a mixed system including hydro-electric and thermal power plants under highly uncertain conditions for the future. These approaches to climatic variations are sensitive with respect to precipitation and air temperature. In terms of balancing the offer with the demand for electricity, the importance of climatic uncertainty depends on the timescale considered and the quality of the available forecasting system. On a medium-term and long-term basis, a better knowledge of the future will prove to be of critical importance in the field of electricity in France and throughout Europe. (See also W90-09088) (Fish-PTT)
W90-09106

ENVIRONMENTAL IMPACT ON CLIMATE DUE TO MANMADE RESERVOIRS.
Centro di Ricerca Idraulica e Strutturale, Milan (Italy).
For primary bibliographic entry see Field 2A.
W90-09107

ANTHROPOGENIC CHANGES OF CLIMATE, WATER RESOURCES AND WATER MANAGEMENT PROBLEMS.
Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR).
For primary bibliographic entry see Field 2A.
W90-09108

FLOOD POTENTIAL, AN UNCERTAIN ESTIMATE RESULTING FROM CLIMATIC VARIABILITY AND CHANGE.
Hydrographisches Zentralbuero, Vienna (Austria).
For primary bibliographic entry see Field 2A.
W90-09109

IMPACT OF CLIMATE VARIABILITY AND CHANGE ON WATER RESOURCES MANAGEMENT IN AGRICULTURE.
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Geographisches Inst.
J. Nemec.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 357-371, 2 fig,

2 tab, 7 ref.

Descriptors: *Agricultural watersheds, *Climatic changes, *Climatology, *Developing countries, *Global warming, *Irrigation programs, *Water resources management, Available water, Crop production, Crops, Drought, Environmental impact, Floods, Population density.

The impact assessment of climatic change on management of water resources in agriculture is a subset of assessment of impact on agriculture. The question arises whether the climatic change will increase or decrease the availability of water needed by the crops as provided at present by water management measures. When taking into consideration the two aspects of the question, namely, the population potential of rainfed lands at low input levels and the continental distribution of irrigated area, it appears that in order to secure a larger food supply for the population toward the year 2000, major improvements in water resources management will be necessary in large areas of the developing world. This rather uneasy situation will further depend on the capacities of the governments to: (1) offset the impact of the deteriorating environment and thus provide a sustainable development which would prevent such deterioration; and (2) offset the impact of the possible changing climate which, in the water management context, means not only to improve food security by irrigation in regions of increasing drought conditions, but also to provide sufficient amounts of drinking water and to prevent catastrophes that may result from an increased frequency of floods. (See also W90-09088) (Fish-PTT)
W90-09110

ASSESSMENT OF CLIMATIC CHANGES IMPACTS ON WATER RESOURCES MANAGEMENT IN AN IRRIGATED ZONE.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
V. G. Pryazhinskaya.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 372-382, 1 fig, 1 tab, 3 ref.

Descriptors: *Agricultural hydrology, *Climatic changes, *Future planning, *Global warming, *Irrigation programs, *Model studies, *Planning, *Water resources management, Environmental impact, Optimization, Simulation analysis.

The methodology for an assessment of the impact of climatic changes on water resources management on a regional scale is based on the application of forecasting models. Regional and global climatic change impacts are simulated with regard to the internal links in the natural-social-economic system. Optimization and simulation models were applied to the evaluation of various production allocation alternatives under changing climatic scenarios with regard to some environmental impacts of agriculture. The model output provides the optimal structure and allocation of crop and livestock production, irrigation water withdrawal and consumption on a monthly basis. The results of the model application are to be used in long-term agricultural planning and feasibility studies in areas with new irrigation development. They contribute considerably to an integrated analysis of both economic and environmental issues and prove the possibility of application of the mathematical models, discussed for assessment of agriculture production and irrigation development strategies changes under various climatic scenarios. (See also W90-09088) (Fish-PTT)
W90-09111

STUDY ON ENERGY FLUXES IN THE SURFACE BOUNDARY LAYER OF THE INDIAN SEAS DURING DIFFERENT EPOCHS OF THE ASIAN SUMMER MONSOON.
Indian Inst. of Tech., New Delhi. Centre for Atmospheric and Fluids Sciences.
U. C. Mohanty, and N. Mohan Kumar.
Atmospheric Environment ATENBP, Vol. 24A, No. 4, p 823-828, 1990. 2 fig, 1 tab, 23 ref.

Descriptors: *Air-water interfaces, *Climatology, *Clouds, *Indian Ocean, *Meteorology, *Model studies, *Monsoons, *Radiation, Air temperature, Climates, Convection, Heat transfer, Marine climates, Meteorological data collection, Moisture, Wind velocity.

The possible link between air-sea interface fluxes of heat and moisture and monsoon activity over the Indian subcontinent was examined using computations of radiative fluxes (shortwave and longwave) and semi-empirical models. Estimations of latent and sensible heat fluxes were carried out using bulk aerodynamic methods. The transfer coefficients for heat and moisture were computed as a function of atmospheric stability and wind speed. The results showed a net oceanic heat loss during the active convective period of the summer monsoon. This net oceanic heat loss produced a positive feedback for the maintenance of deep cumulus convection above the marine boundary layer. The main hindrance in establishing a possible link between the air-sea interface fluxes and monsoon activity over the Indian subcontinent is the paucity of adequate observations over the Indian seas. (Author's abstract)
W90-09114

CHEMICAL COMPOSITION OF INTERCEPTED CLOUDWATER IN THE SIERRA NEVADA.
California Inst. of Tech., Pasadena. W.M. Keck Lab. of Environmental Engineering Science.
For primary bibliographic entry see Field 5B.
W90-09115

SNOW PARTICLE SIZE SPECTRA IN LAKE EFFECT SNOWS.
Chicago Univ., IL.
For primary bibliographic entry see Field 2C.
W90-09122

RAIN ESTIMATION FROM INFRARED AND VISIBLE GOES SATELLITE DATA.
Washington Univ., Seattle. Dept. of Statistics.
F. O'Sullivan, C. H. Wash, M. Stewart, and C. E. Motell.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 3, p 209-223, March 1990. 4 fig, 6 tab, 27 ref.

Descriptors: *Infrared imagery, *Rainfall, *Rainfall estimation, *Remote sensing, *Satellite technology, *Statistical analysis, Comparison studies, Performance evaluation, Rainfall distribution, Weather data collections.

An automated statistical pattern recognition technique is presented that uses visible and infrared (IR) satellite imagery to estimate instantaneous surface rainfall rates. The technique uses both brightness and textural statistics to estimate rainfall in 10 by 10 pixel arrays of satellite data. Each array is centered over one of 137 Service A weather stations scattered over southeastern United States. Surface reports from these stations obtained during a 30 day period in August of 1979 are used to ground truth the technique. The technique classifies each 10 by 10 array into one of three categories: no rain, light rain, moderate/heavy rain. Cross-validation is used to estimate classification errors; results of these estimates yielded an overall error rate of 35% when both visible and IR data are used. When only visible or IR data are used the overall error rates are 39% and 42%, respectively. In addition to the three class problem, the two class problem of classifying rain/no rain is studied. Overall error rates of 18% are achieved using a technique with 16 image statistics and both visible and IR data. A simpler technique that uses only the mean and standard deviation statistics, derived from the visible and IR data, achieved an overall error rate of 20%. The visible and IR pattern recognition technique could be used successfully to estimate instantaneous rainfall in three classes: no rain, light rain, moderate/heavy rain. During the night and during hours of low sun altitude, IR data could be used but with a slight decrease in accuracy. A simpler pattern recognition technique, based upon the mean and standard deviation statistics, could be used to distinguish between rain and no rain classes. (Author's abstract)

W90-09123

STOCHASTIC INTERPOLATION OF RAINFALL DATA FROM RAIN GAGES AND RADAR USING COKRIGING. II. RESULTS.
Utah Water Research Lab., Logan.
D. J. Seo, W. F. Krajewski, A. Azimi-Zonooz, and D. S. Bowles.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 915-924, May 1990. 14 fig, 4 tab, 10 ref.
National Science Foundation Grant ECE-8419189.

Descriptors: *Cokriging, *Data acquisition, *Kriging, *Precipitation, *Radar, *Rain gages, *Rainfall, *Remote sensing, Data interpretation, Estimating, Mathematical studies, Stochastic process.

Several estimation procedures using ordinary, universal, and disjunctive cokriging were evaluated in merging rain gage measurements and radar rainfall data. The radar-gage estimation using ordinary or disjunctive cokriging provided better rainfall estimates than the gage-only or radar-only estimates. However, when radar rainfall data were of known good quality and gage density was high, there was less advantage in combining the two types of data. When rainfall data did not clearly indicate the presence of a nonconstant trend, disjunctive cokriging performed better than ordinary cokriging, but with a 10-fold increase in computer time. When rainfall data did indicate nonhomogeneity in the mean, ordinary cokriging was an inexpensive alternative. Universal cokriging offered little advantage over ordinary or disjunctive cokriging. However, in a few cases it provided better predictions of high rainfall depth when a nonconstant trend was present. Unbiasedness and error variance of kriging and cokriging estimates were affected by the coefficient of variation and correlation distance of the ground truth rainfall, respectively. The potential of cokriging in rainfall estimation was greatly reduced by certain second-order statistics. In cokriging the second-order statistics were estimated only from the presently available data. Then, due to a sparse rain gage distribution, the second-order statistics associated with gage rainfall was estimated with great uncertainty. (See also W90-06856) (Cassar-PTT)
W90-09165

INFLUENCE OF TEMPERATURE VARIATIONS ON INTERCEPTION LOSS AND WATER STORAGE IN VEGETATION CANOPIES.
Leeds Univ. (England). School of Geography.
For primary bibliographic entry see Field 2I.
W90-09167

NORTH PACIFIC CIRCULATION ANOMALIES, EL NINO AND ANOMALOUS WARMTH OVER THE NORTH AMERICAN CONTINENT IN 1986-1988: POSSIBLE CAUSES OF THE 1988 NORTH AMERICAN DROUGHT.
Gesamtverband des Deutschen Steinkohlenbergbaus, Essen (Germany, F.R.).
G. Weber.
International Journal of Climatology IJCLEU, Vol. 10, No. 3, p 279-289, April 1990. 1 fig, 6 tab, 28 ref.

Descriptors: *Climatology, *Data interpretation, *Drought, *El Nino, *Meteorological data collection, *Meteorology, *North America, *Pacific Ocean, Air temperature, Temperature effects.

The relationships between 300/1000 mbar thickness anomalies over the North Pacific Ocean and thickness anomalies over the adjacent North American continent were investigated on the basis of monthly anomalies for the 34 month period January 1986 to October 1988. In 21 out of the 34 months, a pattern was found to exist that linked negative anomalies over the North Pacific Ocean to positive anomalies over the North American continent. Using teleconnection analysis, it was shown that in spring a strong relationship exists between positive anomalies over the western half of the North American continent in mid-latitudes and negative thickness anomalies over the North

Pacific Ocean in tropical and subtropical latitudes. Statistically, the strongest relationships emerged between the thickness gradient departures 20-30 degrees N over the east-central Pacific Ocean and positive anomalies over North America. The abnormal warmth over the North American continent in the springs of 1986, 1987, and 1988 may be explained in terms of an intensified circulation across the Pacific Ocean, which resulted in large positive thickness anomalies downstream over the North American continent. The intensification of those anomalies in the spring of 1988 was found to be a contributing factor to the initiation of the 1988 North American drought. (Author's abstract)
W90-09221

SOME ASPECTS OF DAILY RAINFALL DISTRIBUTION OVER INDIA DURING THE SOUTH-WEST MONSOON SEASON.
Indian Inst. of Tropical Meteorology, Poona.
M. K. Soman, and K. K. Kumar.

Descriptors: *Climatology, *India, *Meteorological data collection, *Monsoons, *Precipitation rate, *Rainfall distribution, Data acquisition, Mathematical equations, Normalized rainfall curves.

The daily rainfall at 365 Indian stations was analyzed for the 80-year period, 1901-1980. The rainfall data related to the south-west monsoon season June to September (122 days), which accounts for the major part of the annual rainfall over most parts of the country. For each of the stations the rain-days were arranged in ascending order of rain amount, and the association between the cumulated percentage rain amount and the cumulated percentage number of rain-days, designated as the normalized rainfall curve (NRC), was calculated. A previously developed equation that relates the cumulated percentage rainfall to the cumulated percentage number of rain days was utilized to study various parameters of the daily rainfall distribution. The coefficient of variation of the daily rainfall series varied between 100% and 230% at individual stations, with nearly half the number of stations having CV values in the range 130-150%. The number of days of significant rainfall (days with rainfall greater than the mean intensity per rain-day) constituted about 30% of the total number of rain-days and account for about 75% of the seasonal rainfall at almost all the stations. (Author's abstract)
W90-09222

TROPICAL CYCLONE SIMULATIONS WITH THE BETTS CONVECTIVE ADJUSTMENT SCHEME. PART I: MODEL DESCRIPTION AND CONTROL SIMULATION.
North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.
J. J. Baik, M. DeMaria, and S. Raman.

Descriptors: *Computer models, *Meteorology, *Model studies, *Tropical cyclones, *Weather forecasting, Cyclones, Storms.

A new convective parameterization scheme was tested in a tropical cyclone model. The convective adjustment scheme adjusts the local temperature and moisture structures towards the observed quasi-equilibrium thermodynamic state and includes nonprecipitating shallow convection as well as deep convection. The numerical model used for this study is an axisymmetric, primitive equation, hydrostatic, finite difference model with 15 vertical levels and a horizontal resolution of 20 km. The spectral radiation boundary condition, which uses a different gravity wave speed for each vertical mode, is implemented in the model. The convective scheme is capable of simulating the developing, rapidly intensifying, and mature stages of a tropical cyclone from a weak vortex. At the mature stage, the minimum surface pressure and maximum low level tangential wind speed of around 923 mb and 58 m/s. During the early

developing stage, the latent heat release is from the convective parameterization, but at the mature stage the latent heat release in mainly due to the grid-scale phase change. For comparison, an experiment was conducted with the parameterized convection excluded, leaving only the grid-scale condensation and evaporation. The results show that the development of a tropical cyclone can be modeled with crude grid-scale condensation and evaporation processes for the 20 km horizontal resolution, similar to other studies. However, a storm with explicit convective latent heat release is considerably less intense than that with the parameterized convective latent heat release. (See also W90-09304) (Author's abstract)
W90-09303

TROPICAL CYCLONE SIMULATIONS WITH THE BETTS CONVECTIVE ADJUSTMENT SCHEME. PART II: SENSITIVITY EXPERIMENTS.
North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.
J. J. Baik, J. DeMaria, and S. Raman.

Descriptors: *Computer models, *Meteorology, *Model studies, *Tropical cyclones, *Weather forecasting, Air pressure, Cyclones, Precipitation, Storms, Water temperature.

Extensive sensitivity experiments were performed with an axisymmetric tropical cyclone model that includes the Betts convective parameterization scheme. The sensitivity of the model storm evolution to the convective adjustment parameters was studied. The results show that the model storm leads to earlier development as the adjustment time scale becomes small and the stability weight on the moist adiabat in the lower atmosphere is increased. The model storm evolution is very sensitive to variations in the saturation pressure departure at the lowermost model integer level and the storm at mature stage has a lower central pressure as the magnitude of the saturation pressure departure is increased. The adjustment parameters affect the grid-scale precipitation as well as the convective precipitation and the precipitation is especially sensitive to changes in the saturation pressure departure. Sensitivity of the model to variations in the sea surface temperature, latitude, initial vortex amplitude, initial moisture distribution, and radiation was also investigated. The results of the numerical simulations are similar to previous studies. Sensitivity studies with various horizontal resolutions show that the subgrid-scale heating becomes a larger fraction of the total heating as the horizontal grid size is increased. (See also W90-09303) (Author's abstract)
W90-09304

TROPICAL PRECIPITATION RATES DURING SOP-1, FGGE, ESTIMATED FROM HEAT AND MOISTURE BUDGETS.
Purdue Univ., Lafayette, IN. Dept. of Earth and Atmospheric Sciences.
C. B. Pedigo, and D. G. Vincent.

Descriptors: *Convective precipitation, *Estimating, *Meteorology, *Precipitation, *Remote sensing, *Tropical regions, Air temperature, Rainfall rate, Satellite technology.

Global estimates of precipitation rates from 30 degrees N to 30 degrees S, derived from the apparent heat source and the apparent moisture sink budgets using the NASA Goddard Laboratory for Atmospheres Level III-b analyses collected during the first special observing period of the Global Weather Experiment are presented. Because of the assumptions made, the techniques yield the most reliable results in the southern hemisphere. Therefore, area averages of precipitation rates were used to examine the variability of rainfall among selected regions in the Southern Hemisphere tropics. These regions include Africa, the Indian Ocean,

the Australian monsoon, the South Pacific convergence zone, and the South America/South Atlantic convergence zone. Time averages of precipitation rates were also calculated for two periods (January 10-24 and January 28-February 11, 1979) that were selected because of significant changes observed in the convective activity. In the first period intense convection was indicated in the South Pacific convergence zone, with a subsequent lack of activity there in the latter period. During the second period, a buildup of convective activity was noted in the Indian Ocean. Vertical profiles of heating are also presented for each region and comparisons are made between the profile for the South Pacific convergence zone and convectively active regions investigated elsewhere in previous studies. Precipitable water was compared to results derived from satellite microwave measurements, as well as the budget-produced precipitation patterns. Results indicate that the heat and moisture budget estimates of precipitation compare favorably. The vertical advection term in both techniques was the dominant contributor to apparent heat source and apparent moisture sink. Vertical profiles reveal that maximum convective heating occurs in the middle troposphere and the profile of the South Pacific convection zone region compares best with those over the western North Pacific. In general, the largest values of precipitable water are observed in the area of lowest outgoing longwave radiation and strongest rainfall rates. Patterns of precipitable water from Goddard Laboratory for Atmospheres compared well with those from the satellite measurements. (Author's abstract)
W90-09305

MESOSCALE ORGANIZATION OF SPRINGTIME RAINSTORMS IN OKLAHOMA.
Washington Univ., Seattle. Dept. of Atmospheric Sciences.
R. A. Houze, B. F. Smull, and P. Dodge.

Descriptors: *Meteorology, *Oklahoma, *Precipitation, *Radar, *Rain gages, *Rainfall, *Storms, Precipitation mapping, Weather, Weather data collections, Wind.

Radar reflectivity and raingage data obtained during six springtimes indicate the types of mesoscale organization that occur in association with major rain events in Oklahoma (at least 25 mm of rain in 24 hours over an area exceeding 12,500 square km). In these storms the primary rain area is found to be a contiguous region of precipitation 10s to 100s of km in scale that consists partly of deep convection and partly of stratiform rain. The patterns of rain formed by the convective and stratiform areas comprise a continuous spectrum of mesoscale structures. About two-thirds of the cases examined exhibited variations on the type of organization in which convective cells arranged in a moving line are followed by a region of stratiform rain. Storm organization was graded according to the degree to which it matched an idealized model of the leading-line/trailing-stratiform structure. The precipitation pattern was further graded according to whether its structure was relatively symmetric with respect to an axis normal to and passing through the midpoint of the line, or asymmetric, in which case the storm was biased toward having stronger, more discrete convective structure at the upwind (south or southwestern) end of the line and/or the most extensive stratiform precipitation behind the downwind (north to northeastern) end of the line. About one-third of the cases examined displayed much more chaotic, unclassifiable arrangements of convective and stratiform areas. (Mertz-PTT)
W90-09306

MOMENTUM AND KINETIC ENERGY BUDGETS OF SIMULATED SUPERCELL THUNDERSTORMS.
Oklahoma Univ., Norman. School of Meteorology.
D. K. Lilly, and B. F. Jewett.

Field 2—WATER CYCLE

Group 2B—Precipitation

Vol. 47, No. 6, p 707, March 15, 1990. 25 fig, 26 ref, append. NSF Grants ATM8300603 and ATM8501380.

Descriptors: *Kinetic energy, *Meteorology, *Simulation analysis, *Storms, *Thunderstorms, Horizontal momentum, Pressure gradient, Supercells, Vertical flux.

The results of numerical simulations of severe thunderstorms with rotating updrafts and supercell characteristics are used to determine their sources, sinks, and transports of momentum and kinetic energy. Two simulations are used, one initiated in an idealized environment with unidirectional shear, and the other simulating a real tornadic storm in an environment with a curved hodograph. For the unidirectional shear storm the analysis is carried out at 10-minute intervals throughout the 2.5 hour duration of the simulation, during which the storm develops a fairly steady amplitude after the first hour but continues to grow in areal extent and in disturbance kinetic energy. Just one time level for the tornadic storm is analyzed. For both storms the vertical flux of horizontal momentum is strongly down the velocity gradient, and the corresponding rate of transfer of disturbance kinetic energy from the mean flow is comparable to that of buoyant energy release. The mean-flow kinetic energy is in both cases partially restored by a gravity wave-generated pressure gradient, which may be considered as an interaction with the environment. The energy budget analysis detects evidence of excessively large artificial damping in the simulation and therefore probably excessive temperature and moisture diffusion. Considerable improvements in understanding might be expected to arise from combined observational and simulation modeling studies, in which the Doppler analyses are used to initialize and verify the simulations, with the simulation results used to fill in the large gaps in the radar data. (Author's abstract)
W90-09326

REVERSALS IN EVOLVING RAINDROP SIZE DISTRIBUTIONS DUE TO THE EFFECTS OF COALESCENCE AND BREAKUP.
Trinity Coll., Hartford, CT. Dept. of Mathematics.
P. S. Brown.
Journal of the Atmospheric Sciences JAHSAK, Vol. 47, No. 6, p 746-754, March 15, 1990. 4 fig, 13 ref. NSF Grant ATM-8722743.

Descriptors: *Meteorology, *Model studies, *Rain, *Raindrop breakup, Coalescence, Marshall-Palmer form, Mathematical models, Size distribution.

Numerical solutions of the coalescence/breakup equation often produce drop size distributions that move away from equilibrium before turning back. In particular, distributions evolving from Marshall-Palmer form rapidly overshoot their equilibrium position, reverse direction, and then settle slowly toward equilibrium. To explain such reversals in the changing drop distribution, an analysis has been performed using a simple model that contains only three drop-size categories. From several basis properties of the coalescence/breakup process, it is shown that the distribution is forced to develop an excess (deficit) of both large and small drops balanced by a deficit (excess) of medium-sized drops. The ratio of excess water mass in the small-drop category to that in the large-drop category approaches a constant value as the distribution approaches equilibrium. In an effort to achieve this proportion, a reversal occurs in some part of the drop distribution. Whether the reversal occurs in the small-drop end or the large-drop end depends on the relative sizes of the initial small-drop and large-drop populations. The initial response of the system is rapid, but after the rapidly decaying transient component dies out, the final approach to equilibrium is characterized by slow adjustment of the drop distribution. (Author's abstract)
W90-09327

ATMOSPHERIC DEPOSITION.
For primary bibliographic entry see Field 5B.
W90-09408

SIMULATED GLOBAL DEPOSITION OF RE-ACTIVE NITROGEN EMITTED BY FOSSIL FUEL COMBUSTION.
National Oceanic and Atmospheric Administration, Princeton, NJ. Geophysical Fluid Dynamics Lab.
For primary bibliographic entry see Field 5B.
W90-09409

COMPARISON OF PARAMETERIZED NITRIC ACID REMOVAL RATES USING A COUPLED STOCHASTIC-PHOTOCHEMICAL TROPO-SPHERIC MODEL.
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
For primary bibliographic entry see Field 5B.
W90-09410

MODELING THE FORMATION AND DEPOSI-TION OF ACIDIC POLLUTANTS.
State Univ. of New York at Albany. Atmospheric Sciences Research Center.
For primary bibliographic entry see Field 5B.
W90-09411

PRECIPITATION DATA COMPATIBILITY IN NORTH AMERICA AND THE IMPACT ON STUDIES OF ACID DEPOSITION.
Canadian Climate Centre, Downsview (Ontario).
For primary bibliographic entry see Field 7B.
W90-09414

WMO SOLID PRECIPITATION MEASURE-MENT INTERCOMPARISON: OBJECTIVES, METHODOLOGY, ANALYSIS.
Atmospheric Environment Service, Downsview (Ontario).
For primary bibliographic entry see Field 7A.
W90-09415

WIND FIELD DEFORMATION ABOVE PRE-CIPITATION GAUGE ORIFICES.
Eidgenoessische Technische Hochschule, Zurich (Switzerland).
For primary bibliographic entry see Field 7B.
W90-09416

MONITORING ATMOSPHERIC DEPOSITION IN CALIFORNIA'S SIERRA NEVADA: A COM-PARISON OF METHODS.
Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.
For primary bibliographic entry see Field 7B.
W90-09417

CHEMICAL COMPOSITION OF PRECIPITA-TION, DEW AND FROST, AND FOG IN DENVER, COLORADO.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-09418

DISTRIBUTION, CHEMICAL AND ISOTOPIC CHARACTERISTICS OF PRECIPITATION EVENTS IN AN ARID ENVIRONMENT - MAKHTESH RAMON BASIN, ISRAEL.
Hebrew Univ. of Jerusalem (Israel). Seagram Centre for Soil and Water Sciences.
For primary bibliographic entry see Field 5B.
W90-09419

COMPARISON OF IONIC COMPOSITION OF CLOUDWATER WITHIN AND ABOVE THE CANOPY OF AN ABOVE CLOUDBASE FOREST.
North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.
For primary bibliographic entry see Field 5B.
W90-09420

APPLICABILITY OF PRINCIPAL COMPO-NENTS ANALYSIS FOR DETERMINING SOURCES OF WET DEPOSITION.

Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-09423

INFORMATION CONTENT EVALUATION FOR ACID DEPOSITION NETWORK REME-DIATION.
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W90-09424

STOCHASTIC MODELING OF RAINFALL PROCESSES IN THE CENTRAL AFRICAN TROPICS.
Department of Water Affairs, Maseru (Lesotho).
T. C. Sharma.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 145-150, 1 fig, 1 tab, 5 ref.

Descriptors: *Africa, *Data acquisition, *Meteorology, *Model studies, *Rainfall distribution, *Stochastic models, *Tropical regions, Chambeshi River Basin, Probability distribution, Rainfall, Seasonal variation, Statistical analysis.

The tropical basins in Central Africa, south of the equator, are largely drained by two major river systems, namely the Congo and the Zambezi. The Congo system drains to the Atlantic Ocean and the Zambezi to the Indian Ocean. Both these rivers originate from Zambia, a country lying entirely in the tropics. Therefore, the Chambeshi basin in the Zambian territory was chosen for studying the stochastic behavior of the rainfall processes. The Chambeshi forms the headwaters of the Congo system of drainage and adequately represents the rainfall conditions of Central African tropical regions. The climate of the basin is very similar to the climate of Zambia. The outstanding feature of Zambia's climate is that the bulk of rainfall is concentrated into six months (November-April). The remaining months are almost dry. It was found that: (1) a monthly rainfall sequence can be approximated by a normal probability distribution with the deterministic periodic component accounting for 72% to 83% of the variation and an independent stochastic component for the remainder. The characteristics of the stochastic component resemble that of a white noise process. The characteristics of rainfall from December to March are identical with the mean value ranging from 225 mm to 260 mm and coefficient of variation ranging from 0.25 to 0.40. The monthly and yearly rainfall sequences can be adequately simulated using means and standard deviations for the months of November and April, and a common value of mean and standard deviation for December through March; and (2) the yearly rainfall sequences in the basin follow a normal probability law and can be approximated by a white noise process. The mean of the yearly rainfall depth sequences is of the order to 1080 to 1300 mm with coefficient of variation ranging from 0.15 to 0.20. A white noise model appeared satisfactory for synthesizing yearly rainfall sequences. (See also W90-09408) (Lantz-PTT)
W90-09425

REGIONAL SIMULATION OF SURFACE WATER ACIDIFICATION: UNCERTAINTY DUE TO SPECIFICATION OF ATMOSPHERIC DEPOSITION.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W90-09426

ATMOSPHERIC DEPOSITION OF SULFUR TO A GRANITE OUTCROP IN THE PIED-MONT OF GEORGIA, U.S.A.
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 5B.

W90-09428

FOLIAR ABSORPTION OF 15-N LABELED NITRIC ACID VAPOR (HNO3) IN MATURE EASTERN WHITE PINE (PINUS STROBUS L).

Southeastern Forest Experiment Station, Otto, NC. Coweeta Hydrologic Lab.
For primary bibliographic entry see Field 5B.
W90-09432

BULK PRECIPITATION DEPOSITION OF INORGANIC CHEMICALS IN FOREST AREAS AND ITS INFLUENCE ON WATER QUALITY IN THE FEDERAL REPUBLIC OF GERMANY.

Hessian Forest Research Station, Hann. Muenden (Germany, F.R.). Inst. of Forest Hydrology.
For primary bibliographic entry see Field 5B.
W90-09433

LEACHING OF STRONG ACID ANIONS FROM SNOW DURING RAIN-ON-SNOW EVENTS: EVIDENCE FOR TWO COMPONENT MIXING.

Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
For primary bibliographic entry see Field 5B.
W90-09435

APPLICATION OF THE STEP-DURATION OROGRAPHIC INTENSIFICATION COEFFICIENT METHOD TO THE ESTIMATION OF OROGRAPHIC EFFECTS ON RAINFALL.

Hohai Univ., Nanjing (China). Dept. of Hydrology.
L. Bingzhang.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 259-266, 3 fig, 1 tab, 5 ref.

Descriptors: *China, *Data interpretation, *Meteorology, *Orographic precipitation, *Orography, *Topography, Mathematical studies, Rainfall, Storms.

For the study of probable maximum precipitation (PMP) in mountainous regions the most difficult and important task is the estimation of the effects of topography on storm rainfall. The step-duration orographic intensification coefficient (SDOIC) method is based on synoptic climatic and topographic analyses of the relevant region, and statistical analysis of the observed local rainfall. The method permits quantitative estimates to be made regarding the physically-based effect of a particular watershed terrain on rainfall. It includes variations in both space and time by means of a two-dimensional discrete scheme. An example is presented of PMP estimates for the Daguangba Catchment in the Changhua River on the Island of Hainan, in which the following conclusions were drawn: (1) Storm rainfall is strongly related to regionality, with regard to the amount of rain and its distribution both in time and space, in China; (2) It is impossible and unreasonable to transpose orographic storm rainfall without adjustment. Only the convergent component with its distributions both in time and space can be transposed within a broader area. Therefore, if the orographic storm rainfall is separated into two components, the convergent and the orographic, the SDOIC method can be used to determine the orographic effect and the convergent component can be transported; and (3) The successful use of the SDOIC method is only for those areas where a series of observed rainfall data at any one of the well-distributed rain gage stations is available. (See also W90-09408) (Lantz-PTT)
W90-09437

HYDROMETEOROLOGICAL CHARACTERISTICS OF THE TIBET PLATEAU.

Nanjing Hydrological Research Inst. (China).
For primary bibliographic entry see Field 2A.
W90-09438

ANALYSIS OF DIABATIC WIND AND TEMPERATURE PROFILES OVER THE AMAZONIAN FOREST.

Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
Y. Viswanadham, V. P. Silva Filho, A. O. Manzi, and L. D. A. Sa.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 281-288, 2 fig, 1 tab, 14 ref.

Descriptors: *Amazon River Basin, *Meteorology, *Rain forests, *Temperature, *Wind, Deacon number, Hydrologic budget, Mathematical studies.

The micrometeorological research program for the Amazonian Forest has provided extensive data on wind and temperature profile structures under lapse to extreme inversion conditions. Significant variations in the determinations of surface roughness and zero-plane displacement from quasi-neutral wind profiles were noted. Differences in the shear stress are largely dependent on the selected surface roughness and zero-plane displacement. The Deacon numbers for wind and potential temperature were computed to investigate, in detail, the curvatures of these profiles. A relation between Deacon numbers and the Richardson gradient number was obtained. The empirical relationship between the Deacon numbers and Richardson gradient number seems to become erratic for strong inversion conditions. The ratio of the eddy coefficient for heat to the eddy coefficient for momentum is greater than unity for all stabilities and slowly decreases for large values of the Richardson gradient number. This study shows that it is possible to compare the results of observed data with theoretical models. (See also W90-09408) (Author's abstract)
W90-09439

2C. Snow, Ice, and Frost

FIELD MEASUREMENTS OF SEDIMENT TRANSPORT PARAMETERS IN ESTUARIES.

Birmingham Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W90-08736

GLOBAL SNOW DEPTH CLIMATOLOGY.

Air Force Environmental Technical Applications Center, Scott AFB, IL.
D. J. Foster, and R. D. Davy.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A203 969. Price codes: A04 in paper copy, A01 in microfiche. Report No. USAFETAC/TN-88/006, December 1988. 48p, 2 fig, 83 ref, 30 append.

Descriptors: *Climatology, *Data collections, *Databases, *Snow depth, *Snow surveys, Hydrologic data collections, Snow density.

The Air Force Global Weather Central runs its Snow Analysis Model (SNODEP) once a day to produce daily global snow age and depth analyses. A new snow depth climatic database has been developed to fill three needs connected with this model: (1) incorporate current data sources; (2) full documentation; and (3) capability for easy updating. SNODEP climatology uses the standard eighth mesh reference grid. Snow depth information was obtained from an extensive literature search with a 'confidence'factor assigned to each source. Data was plotted on hemispheric maps, month by month. The entire eighth mesh boxes from the digitized data were printed out by computer and checked against the original analysis for quality control. A method was developed for estimating mean snow-depths for data-sparse areas, such as Antarctica, China, and Greenland and the Arctic. Information is included for potential users on how to order data from the Snow Depth Database how to order data. Contoured charts that show mean mid-month snow depths for September through June in North America, Europe, And Asia are included in an appendix. (Lantz-PTT)

W90-08765

SEASONAL SNOWFALL STATISTICS FOR SELECTED STATIONS.

Air Force Environmental Technical Applications Center, Scott AFB, IL.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A203 965. Price codes: A03 in paper copy, A01 in microfiche. Report No. USAFETAC/TN-88/005, October 1988. 33p.

Descriptors: *Climatology, *Data collections, *Seasonal variation, *Snow surveys, *Statistics, Hydrologic data collections, Snow density.

Seasonal snowfall statistics at 64 selected locations worldwide are tabulated. Data is for the 10-year period from 1976 to 1986. Total snowfall amounts for each season (defined as July of one year to June of the next) is provided, along with 24-hour snowfall extremes, and dates. Seasonal means and standard deviations are also given. (Lantz-PTT)
W90-08766

RECENT TRENDS IN GLACIERS AND GLACIER RUNOFF, WIND RIVER RANGE, WYOMING.

Wyoming Univ., Laramie. Dept. of Geography and Recreation.
R. A. Marston, L. O. Pochop, G. L. Kerr, and M. L. Varuska.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 159-169, 5 fig, 2 tab, 21 ref.

Descriptors: *Glaciers, *Glaciohydrology, *Headwaters hydrology, *Runoff, Dinwoody Glacier, Gannett Glacier, Glacial drift, Green River, Headwaters, Hydrologic budget, Snowmelt, Water supply, Wind River, Wyoming.

The largest concentration of glaciers in the American Rocky Mountains occurs in the Wind River Range of Wyoming, but the contribution of glacier meltwater to flow in headwater streams of the Green River and Wind River drainages has not been documented. The present study documents the loss of ice in Dinwoody and Gannett Glaciers since the 1930's and the importance of glacier meltwater to overall water supply in the Green River and Wind River drainages. Both glaciers have retreated and lost thickness in the last five decades, but repeat photography revealed that Dinwoody Glacier has responded more dramatically than Gennett Glacier to the unfavorable climatic conditions. This contrast can be explained by the difference in area-elevation curves between the two glaciers. The estimated glacier meltwater from Dinwoody and Gannett Glaciers amounts to 27% of the September runoff and 32% of the October runoff in lower Dinwoody Creek. The July-October runoff from glaciers in the Wind River Range is approximately 70 million cu m, or 8% of the average runoff in the Wind River and Green River basins during that four-month period. (See also W90-08822) (Author's abstract)
W90-08840

SNOW COVER AND SNOWMELT RUNOFF MODEL IN THE FOREST ZONE.

Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
J. Motovilov, and B. Vehvilainen.
Publications of the Water and Environment Research Institute PWEIET, No. 3, p 17-26, 1989. 5 fig, 1 tab, 8 ref.

Descriptors: *Finland, *Hydrologic models, *Model studies, *Runoff, *Snowmelt, *Soviet Union, Forest watersheds, Frost, Frozen ground, Albedo, Governmental interrelations, Hydrographs, Infiltration, Mathematical models, Physical models, Soil water.

Conditions of snowmelt runoff formation are similar in the watersheds of Finland and in the northwestern part of the USSR forest zone. In operative

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hydrologic practice of the Finnish National Board of Waters and the Environment, a modification of the conceptual model HBV-3 is to be used for calculations and forecasts of the spring flood hydrograph. These activities are part of a Soviet-Finnish scientific cooperation program. The HBV-model contains a simplified description of the following processes: snow cover formation and snow melting, infiltration and accumulation of meltwater in the soil in the aeration zone, and formation of surface, subsurface, and groundwater runoff. A physically-based model such as HBV should be better than the common degree-day snow models normally used in catchment hydrology. This criterion is at present not achieved with the HBV model or with any other physical snow cover model. However, the physically-based snow cover model gives a lot of information on the different processes included in snow accumulation and snow melt that can be used in developing simpler snow models. Also, physically-based snow models can simulate quite accurately different snow characteristics, such as snow density and depth, which can be used in such other studies as soil frost simulation or calculating of snow albedo. (Rochester-PTT) W90-09028

MERCURY CONTENT OF ANTARCTIC SURFACE SNOW: INITIAL RESULTS.
Department of Scientific and Industrial Research, Petone (New Zealand). Chemistry Div.
A. L. Dick, D. S. Sheppard, and J. E. Patterson.
Atmospheric Environment ATENBP, Vol. 24A, No. 4, p 973-978, 1990. 1 fig, 3 tab, 23 ref.

Descriptors: *Antarctica, *Chemistry of precipitation, *Mercury, *Pollutant identification, *Snow, *Water analysis, Heavy metals, Laboratory methods, Snow sampling, Water pollution sources.

Surface snow from Windless Bight, Ross Ice Shelf, Antarctica was analyzed for its mercury (Hg) content. Ultra-clean techniques were used for field extraction of Hg onto gold-coated sand, followed by photo-acoustic analysis within 24 hr. Results yield a mean Hg content of 2.7 picograms/gm. However, the true level is probably < 1 picogram/gm, as measured amounts decreased throughout the period of sampling, indicating that the first samples were probably contaminated and that later results are likely to be more accurate. *The results suggest that previous studies of Antarctic snow have suffered from major contamination problems. Refinement of techniques should allow historical trends in atmospheric Hg levels to be identified from a snow pit at a suitable remote site. (Author's abstract)
W90-09116

SNOW PARTICLE SIZE SPECTRA IN LAKE EFFECT SNOWS.
Chicago Univ., IL.
R. R. Braham.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 3, p 200-207, March 1990. 6 fig, 4 tab, 22 ref. NSF Grants ATM83-10429 and ATM86-17177.

Descriptors: *Blizzards, *Lake Michigan, *Lake effect, *Snow, *Snow sampling, *Spectral analysis, Mathematical studies, Particle size, Snow surveys.

In situ snow particle size spectra was measured by Particle Measuring Systems probes near the downwind shore of Lake Michigan during lake-effect snow storms. Results of forty-nine samples showed that the particles appeared to be predominantly spatial dendrites and aggregates of dendritic forms, but limited resolution of the probes for snow particles obscured details of crystal structures. Exponential distributions fitted to data for sizes larger than 1 mm were used to calculate several distribution parameters. Particle concentrations implied by the exponential distribution ranged from 0.36 to 5.85/L; ice-water contents ranged from about 0.002 to 0.264 g/cu m. Concentrations of sizes larger than 1 mm were generally exponentially distributed; however, concentrations of smaller particles usually were greater than suggested by the exponential fitted to concentrations of sizes larger than 1 mm. Exponential distribution param-

eters (zero intercept and slope) were consistent with previously reported values. There was evidence for particle aggregation at -25 C. (Geiger-PTT)
W90-09122

MODELING OF MELTWATER INFILTRATION IN SUBFREEZING SNOW.
Colorado Univ., Boulder. Dept. of Civil, Environmental, and Architectural Engineering.
T. H. Illangasekare, R. J. Walter, M. F. Meier, and W. T. Pfeffer.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 1001-1012, May 1990. 9 fig, 3 tab, 30 ref. U.S. Department of Energy Grant DE-FGO2-87ER60570.

Descriptors: *Infiltration, *Model studies, *Snow, *Snowmelt, Freezing, Greenhouse effect, Heat transfer, Heterogeneity, Mathematical studies, Particle size, Snowpack, Temperature effects, Thawing, Water flow.

A mathematical model incorporating the processes that influence water flow and heat transfer in subfreezing snow was developed. Among the aspects of snow included were density and grain-size heterogeneities, capillary-pressure gradients, meltwater refreezing, time dependent hydraulic and thermal parameters, and heat conduction. From this conceptual mathematical model a numerical model of two-dimensional meltwater infiltration was developed. Results from various test cases showed which data were most important to measure accurately in the field, in order to determine how the snowpack will respond to an introduction of meltwater. These simulations also showed the importance of the orientation of the various layers which make up the snowpack and how randomly distributed heterogeneities can produce two-dimensional flow of meltwater under unsaturated conditions. Finally, it was demonstrated that various assumptions related to density and porosity variations, dimensionality of flow, capillary effects, etc., which were made by past investigators for ideal situations may not be valid under many circumstances. Several suggestions were made for improving predictions of meltwater behavior. Sensitivity analysis showed that the model was most sensitive to changes in bulk density, residual saturation of wet snow, and meltwater supply rates, whereas changes in snow temperature and mean grain size had less marked effect. (Author's abstract)
W90-09172

SNOWMELT RUNOFF MODELING IN A BALSAM FIR FOREST WITH A VARIABLE SOURCE AREA SIMULATOR (VSAS2).
Laval Univ., Quebec. Lab. d'Hydrologie Forestiere.
M. Prevost, R. Barry, J. Stein, and A. P. Plamondon.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 1067-1077, May 1990. 8 fig, 4 tab, 30 ref.

Descriptors: *Forest hydrology, *Forests, *Model studies, *Runoff, *Snowmelt, Frozen ground, Infiltration, Lac Laflamme Basin, Lakes, Mathematical models, Quebec, Recharge, Simulation, Snow cover, VSAS2 model, Water level.

The variable source area model of storm flow generation (VSAS2) was adapted to simulate snowmelt runoff in the Lac Laflamme forested basin 80 km north of Quebec City. The model was adapted to accept different water inputs according to topography, to factor the effect of lake water storage in the discharge hydrograph and to process 3 months of hourly data. To ensure convergence of the mathematical solution, the explicit form of flow equations included in VSAS2 was transformed to use an iterative approach. Lysimeter measurements and outputs from the snowmelt temperature index model SNOW-17 were used as input data in the simulation. Results showed that low flows in early spring were well reproduced by the physically based model. However, all seasonal (1985, 1986, 1987) peak flows were underestimated when all water input was considered to infiltrate. Observations on the site showed that the natural

topographical drainage network was augmented in the spring by superficial concrete frost, pipe throughflow at the organic-mineral soil interface and snowpack basal ice layers. It was therefore necessary to use an infiltrability index to improve the model. Because it was closely related to the development of an impervious layer at the soil surface, the relative proportion of bare ground areas on the basin was also related to the rising of streamflow hydrographs. Thus values of snow cover areal extent were taken from SNOW-17 outputs and used as an index to the prevailing conditions of soil infiltrability on the basin. Results from VSAS2 were greatly improved, supporting the hypothesis of an important surface flow contribution during late snowmelt. (Author's abstract)
W90-09177

APPLICATION OF A SNOW COVER ENERGY AND MASS BALANCE MODEL IN A BALSAM FIR FOREST.
Laval Univ., Quebec. Lab. d'Hydrologie Forestiere.
R. Barry, M. Prevost, J. Stein, and A. P. Plamondon.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 1079-1092, May 1990. 14 fig, 6 tab, 47 ref.

Descriptors: *Energy, *Forests, *Model studies, *Runoff, *Snow cover, *Snowmelt, Canopy, Forest hydrology, Heat balance, Heat transfer, Ice lenses, Lac Laflamme Basin, Mass balance, Mathematical models, Quebec, Snowpack, Temperature, Wind effects.

The parameters of a previously developed point energy and mass balance model of a snow cover were adjusted as applied to a balsam fir forest during spring in the Lac Laflamme, Quebec, region. This physically based model was used to simulate the snow cover energy and mass balance during spring. The model was calibrated with the physical properties of snow and hourly outflow observed at a snow lysimeter in 1985 and 1986. The validation was performed with the 1987 data. For the three seasons simulated, the model yielded accurate predictions particularly of hourly and daily outflows. The forest canopy limited latent and sensible heat transfer to the snow cover because of its effect on wind speed. The prediction of outflow was almost insensitive to variations to the roughness parameter and to the critical Richardson number but was moderately sensitive to most parameters related to liquid water retention and transmission. Lack of fit between predicted and observed outflows, densities and temperatures at various levels in the snowpack occurred when ice layers or ice lenses were suspected to be present. (Author's abstract)
W90-09178

HEAVY SNOWFALL WITHIN A MESOSCALE CONVERGENCE ZONE.
Meteorological Office, High Wycombe (England).
R. M. Sanderson, B. W. Golding, and M. J. Bader.
Meteorological Magazine MTMGA5, Vol. 119, No. 1412, p 41-52, March 1990. 16 fig, 1 ref.

Descriptors: *Infrared imagery, *Meteorology, *Model studies, *Remote sensing, *Satellite technology, *Snow accumulation, *Weather forecasting, Data interpretation, England, Meteorological data collection.

The localized heavy snowfall over central southern England on the night of 18/19 March 1987 was investigated using mesoscale-model output and satellite and radar imagery. It caused considerable disruption to power supplies and road traffic. Satellite and radar images showed that the snow fell a few hundred kilometers east of an initially conspicuous, well-developed comma cloud that moved south-east in a decaying state across Cornwall, and did not fall from cloud that developed, as is more usual, along the tail of the comma. Forecasts from the mesoscale model and frequent monitoring of the satellite and radar images can enable the forecaster to justify playing down the likely impact of an initially conspicuous feature (the comma) in favor of a probable new important mesoscale de-

velopment (i.e. the band of heavy snow) that does not conform with conventional ideas (i.e. the development of precipitation along an existing comma tail). The diagnostics from the mesoscale model, supported by those from the fine-mesh model, can enhance the understanding of the main physical and dynamical processes at work. (Chonka-PTT)
W90-09227

2D. Evaporation and Transpiration

VARIABLE LANDSCAPE AGGREGATION FOR LARGE SCALE WATERSHED EVAPOTRANSPIRATION ESTIMATES.
Montana Univ., Missoula. School of Forestry.
J. C. Coughlan, and S. W. Running.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 75-82, 3 fig, 10 ref. NASA Grant NAGW-252.

Descriptors: *Evapotranspiration, *Forest watersheds, *Headwaters hydrology, *Model studies, *Vegetation, Computer models, Data interpretation, Evaporation, Remote sensing, Satellite technology, Transpiration.

A modeling framework has been developed that is parameterized with readily available data collected from satellites and digital elevation maps, and driven with routine meteorological data. It incorporates topographic influences on microclimate producing biophysically based estimates of forest evapotranspiration (ET). The resolution of topographic and vegetation data is initially determined by DEMs and LANDSAT imagery, both at 30M pixel resolution. The initial parameterization is too detailed for practical applications; therefore, aggregation is necessary before executing the ET model. Three computer based methods for aggregating spatial data are presented; grid, topographic and expert. Each differs by the amount of information it uses to aggregated data. The grid method aggregates indiscriminately, the topographic method aggregates based on topography and the expert method uses all data to explicitly infer information to aid in aggregating. (See also W90-08822) (Author's abstract)
W90-08830

EVAPOTRANSPIRATION OF COOL-SEASON GRASSES GROWN WITH MINIMAL MAINTENANCE.
Oregon State Univ., Corvallis. Dept. of Horticulture.
For primary bibliographic entry see Field 2I.
W90-08895

ENERGY BALANCE AND WATER USE OF CROPS.
Nebraska Univ.-Lincoln. Center for Agricultural Meteorology and Climatology.
For primary bibliographic entry see Field 3F.
W90-08919

SHORT-TERM ESTIMATION OF SORGHUM EVAPOTRANSPIRATION FROM CANOPY TEMPERATURE.
Texas Agricultural Experiment Station, Temple. Blackland Research Center.
K. L. Faver, J. C. O'Toole, and D. R. Krieg.
Agricultural and Forest Meteorology AFMEEB, Vol. 48, No. 1/2, p 175-183, October 1989. 2 fig, 1 tab, 18 ref.

Descriptors: *Agriculture, *Evapotranspiration, *Plant physiology, *Sorghum, *Water stress, Air temperature, Cloud cover, Lysimeters.

A study was conducted to compare calculated evapotranspiration values using canopy and aerodynamic resistances derived by two methods with measured evapotranspiration (ET) from a weighing lysimeter. Grain sorghum (Sorghum bicolor (L.) Moench) mean potential canopy and aerodynamic resistances were estimated from the linear relationship between sorghum canopy minus air

temperature and air vapor pressure deficit. Additionally, wind speed-dependent aerodynamic resistance estimates were used. High-frequency short-term (10 minute) estimates of crop evapotranspiration were made under clear and partly cloudy sky conditions. The agreement between calculated ET and measured ET from the lysimeter was optimum when mean potential canopy and wind speed dependent aerodynamic resistance estimates were utilized ($r=0.95$, $RMSE=0.06$ mm/hour, $MB=-0.042$ mm/hour) during clear sky conditions. On a day with partly cloudy sky conditions, the relationship was slightly less correlated ($r=.81$, $RMSE=0.12$ mm/hour, $MB=-0.036$ mm/hour) but the method's ability to track rapidly changing ET rates was notable. Short-term or high-frequency estimates of ET could be useful for crop-level physiological studies of response to water stress, and irrigation water management research. (Author's abstract)
W90-08920

EVAPOTRANSPIRATION FROM AN OAK FOREST INFESTED BY MISTLETOE.
Universitaet fuer Bodenkultur, Vienna (Austria). Inst. fuer Meteorologie, Klimatologie und Grundlagen der Physik.
C. Bernhofer.
Agricultural and Forest Meteorology AFMEEB, Vol. 48, No. 3/4, p 205-223, November 1989. 6 fig, 1 tab, 24 ref.

Descriptors: *Evapotranspiration, *Forest ecosystems, *Forest hydrology, *Instrumentation, *Mistletoe, *Oak, *Water stress, Bowen ratio, Canopy resistance, Diurnal variation, Energy transfer, Seasonal variation, Stomatal transpiration.

Energy flux partitioning of a mature oak forest (predominantly Quercus petraea) infested by mistletoe (Loranthus europaeus) was investigated in August 1987 with a precise Bowen ratio energy balance (BREB) system. The microcomputer-controlled BREB system, which automatically interchanges two precision psycrometers at 6-minutye intervals, was mounted on a tower at 21 m, just above the canopy. Radiative fluxes were measured by two net radiometers and a star pyranometer at the top of the tower. Two soil heat flux sensors were displayed 1 cm beneath the surface. Data were checked for consistency and integrated into half-hourly means for 8 days with conditions ranging from clear and warm to cool and moist. Evapotranspiration totals ranged from 2 mm/day on overcast days up to 4.6 mm/day on clear days. The daily course of latent heat flux showed a midday depression on days with large vapor pressure deficits, but followed net radiation quite closely on days with smaller vapor pressure deficits. Evapotranspiration was examined throughout the day with respect to the bulk stomatal resistance of the canopy, computed from the Penman-Monteith model for latent heat flux. The analysis of canopy resistance shows more clearly than the Bowen ratio the consistency of the anomalous reduction in evapotranspiration in early afternoon on days with larger vapor pressure deficits. In contrast, canopy resistance remained rather uniform throughout cooler days with lower vapor pressure deficits. The midday increase in canopy resistance and reduction in latent heat flux on the warmer days is attributed to stomatal closure of the oak leaves, associated with late summer water stress exacerbated by the heavy mistletoe infestation. (Brunone-PTT)
W90-08921

EVALUATING WATER FLUXES OF FIELD-GROWN ALFALFA FROM DIURNAL OBSERVATIONS OF NATURAL ISOTOPE CONCENTRATIONS, ENERGY BUDGET AND ECOPHYSIOLOGICAL PARAMETERS.
Paris-6 Univ. (France). Lab. de Biogeochmie des Isotopes Stables.
T. Bariac, S. Rambal, C. Jusserand, and A. Berger.
Agricultural and Forest Meteorology AFMEEB, Vol. 48, No. 3/4, p 263-283, November 1989. 8 fig, 3 tab, 53 ref.

Descriptors: *Crop production, *Evapotranspiration, *Isotopic tracers, *Plant physiology, *Plant

water potential, *Soil water, *Stomatal transpiration, Deuterium, Diurnal variation, Mediterranean Region, Oxygen isotopes, Physical models.

The isotopic composition of water in soil, plant, and atmospheric vapor was used to investigate the flow processes in an alfalfa canopy during a typical summer day under Mediterranean climate. In addition to the stable isotopes of water, energy budget, leaf water potential and stomatal conductance were used in an integrated approach to a better understanding of the mechanisms of water transfer. The daily enrichment cycle of oxygen-18 and deuterium in the leaves can be described by a physical model assuming that one of the important factors influencing the daily variation of oxygen-18 and deuterium content is the daily humidity cycle. The isotopic composition of the input water can either be determined by the collar water or by the water of the soil layers supplying water to the active roots. There is no fractionation during water uptake by the roots. Total resistance to water flow in alfalfa calculated using an Ohm's law analog was similar to other reported values. However, alfalfa contains internal stores of water. Differences between transpiration and root water uptake can be interpreted as indicating that these internal stores contribute substantially to transpiration during the day. Upshifts and downshifts in the isotopic composition of leaves are due to contributions from these internal stores and can probably result from a modification of the values of the kinetic fractionation factor in relation to the changes in the aerodynamic regime and the stomatal opening. (Author's abstract)
W90-08922

INFLUENCE OF WATER DEFICIT ON TRANSPIRATION AND RADIATION USE EFFICIENCY OF CHICKPEA (CICER ARIETINUM L).
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).
For primary bibliographic entry see Field 2I.
W90-08923

EVAPORATION FROM IRRIGATED WHEAT ESTIMATED USING RADIATIVE SURFACE TEMPERATURE: AN OPERATIONAL APPROACH.
Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Centre for Irrigation Research.
For primary bibliographic entry see Field 3F.
W90-08924

APPLICATION OF AN ENERGY COMBINATION MODEL FOR EVAPORATION FROM SPARSE CANOPIES.
Trent Univ., Peterborough (Ontario). Dept. of Geography.
P. M. Lafleur, and W. R. Rouse.
Agricultural and Forest Meteorology AFMEEB, Vol. 49, No. 2, p 135-153, January 1990. 7 fig, 1 tab, 15 ref, append.

Descriptors: *Canopy, *Energy combination model, *Evaporation, *Evapotranspiration, *Mathematical models, *Model studies, *Plant water potential, Diurnal variation, Leaf area index, Net radiation, Penman-Monteith model, Shuttleworth-Wallace model, Subarctic zone, Wetlands.

A previously developed evaporation energy combination model (the Shuttleworth and Wallace (SW) model) was tested with data collected in a subarctic wetland. The modelled evaporation was compared with evaporation calculated from the Bowen ratio energy balance technique over a range of leaf area indices (LAI) from non-vegetated to fully vegetated conditions. The Shuttleworth-Wallace model was in excellent agreement with the measured evaporation for hourly and daytime totals for all values of LAI. This gives a particular advantage to the SW model compared to the Penman-Monteith combination equation. A comparison of measured and modelled total evaporation for all days yielded a root mean square error and mean bias error of 0.98 and -0.13

Group 2D—Evaporation and Transpiration

MJ/sq m/day, respectively. The model also shows good agreement with the measured evaporation on an hourly basis. Although these results encouraging, the test was not truly independent. The need for additional investigation and testing of certain model parameters is recognized. In the study, it was assumed that eddy diffusivity within the canopy decreased exponentially and was controlled by a decay constant which varied with LAI. However, there is little information available to validate this treatment. Net radiation at the soil surface was computed from net radiation over the canopy and an exponential function of LAI, which was held constant over the course of the growing season. (Author's abstract)
W90-08926

COMPARISON OF BOWEN RATIO AND AERODYNAMIC ESTIMATES OF EVAPOTRANSPIRATION.
Laboratoire de Bioclimatologie, Peronne (France).
P. Pieri, and M. Fuchs.
Agricultural and Forest Meteorology AFMEEB, Vol. 49, No. 3, p 243-256, February 1990. 11 fig, 1 tab, 16 ref.

Descriptors: *Aerodynamic estimates, *Agriculture, *Bowen ratio, *Energy transfer, *Evapotranspiration, *Irrigation requirements, Canopy, Diurnal variation, Heat flux, Meteorology, Temperature, Wind speed.

The theoretical validity, instrumentation, and performance of three meteorological determinations of evapotranspiration were compared: (1) Bowen ratio method; (2) aerodynamic method using full profile; and (3) aerodynamic method simplified. The energy balance of an irrigated cotton field was determined using the Bowen ratio to partition between sensible and latent heat flux density. These data verified estimates of the sensible heat flux density derived from either profiles of wind and temperature at six levels, or from a simplified aerodynamic method using wind and temperature differences between two levels only. The full profile provided good estimates of the sensible heat flux density, but the diurnal course lagged by approximately one hour behind the values obtained from the Bowen ratio. The aerodynamic properties of the crop did not appear to be affected by the row structure of the canopy. Results of the simplified method varied with the selection of levels between which the differences were measured. Flux densities determined across some of the layers consistently matched those obtained by the Bowen ratio. The accuracy of the three methods is suitable for estimating the amount of irrigation water based on a determination of evapotranspiration. (Brunone-PTT)
W90-08928

EVALUATING PLANT WATER STRESS WITH CANOPY TEMPERATURE DIFFERENCES.
National Oceanic and Atmospheric Administration, Idaho Falls, ID. Environmental Research Labs.
For primary bibliographic entry see Field 3F.
W90-08929

MODELING WATER TABLE CONTRIBUTION TO CROP EVAPOTRANSPIRATION.
Utah State Univ., Logan. Dept. of Soil Science and Biometeorology.
J. S. Torres, and R. J. Hanks.
Irrigation Science IRSCD2, Vol. 10, No. 4, p 265-279, 1989. 6 fig, 3 tab, 15 ref.

Descriptors: *Evapotranspiration, *Hydrologic models, *Model studies, *Saturated flow, *Water table, Aeration zone, Colombia, Irrigation, Lysimeters, Mathematical models, Prediction, Simulation, Sugarcane.

A model was developed to account for the time-dependent contribution of the water table to crop evapotranspiration (ET). The same numerical approximation used to solve the water flow in the unsaturated zone was modified for saturated conditions. For unsaturated flow, the hydraulic conductivity changes with water content and the specific

water capacity has finite values. For saturated flow, hydraulic conductivity is constant, and the specific water capacity is zero. The proposed approach considers saturated flow as a special case of unsaturated flow, with a constant saturated water content and very small, but not zero, specific water capacities. Flow can be simulated either in unsaturated or saturated zones. The contribution of upward flow to crop ET was evaluated during lysimeter experiments in the greenhouse. Spring wheat was planted on a silty clay loam and a fine sandy loam with either no water table or constant water table depths at 50, 100, or 150 cm. Irrigation was applied whenever soil water was depleted below about 50% plant available water. Model predictions of water content and cumulative upward flux as a function of time, for the different water table depths and soils, agreed closely with measured values. The contribution of the water table to ET was 90, 41, and 7% for 50, 100, and 150 cm water table depths, respectively, for the silty clay loam and 92, 31, and 9% for the fine sandy loam, respectively. Corresponding computed values were 99, 29, and 11%. The model also was used to simulate field irrigation management options under several bottom boundary conditions where the water table contributions were significant to crop water use. Results from a 1-yr simulation were consistent with data for sugarcane grown under similar conditions in the Cauca Valley of Colombia. (Author's abstract)
W90-09018

SENSITIVITY OF PENMAN ESTIMATES OF EVAPORATION TO ERRORS IN INPUT DATA.
Institute of Hydrology, Wallingford (England).
B. S. Piper.
Agricultural Water Management AWMADF, Vol. 15, No. 3, p 279-300, May 1989. 8 fig, 5 tab, 14 ref, append.

Descriptors: *Agriculture, *Evaporation rate, *Evapotranspiration, *Mathematical models, *Penman equation, *Water requirements, Crop production, Data interpretation, Error analysis, Estimating equations, Irrigation requirements, Penman estimates, Seasonal variation, Sensitivity analysis, Temperature effects, Uncertainty.

A reliable estimate of crop water requirements is one of the key design criteria required for the planning and operation of irrigation schemes. This in turn requires accurate estimation of evaporation for which the Penman form of the combination equation is widely used. The sensitivity of evaporation estimates to errors in input data, and to uncertainties in the values of the parameters used in the equation was examined. Results from a wide range of stations over the globe show that estimates are most sensitive to temperature, and that this sensitivity can have a marked seasonal fluctuation. The effects of uncertainty in the equation's parameter values are small and comparable to the sensitivities of the other input variables; wet bulb depression, wind speed, and sunshine hours. (Author's abstract)
W90-09367

2E. Streamflow and Runoff

COMPARISON OF BIOTIC INDEX VALUES FOR INVERTEBRATE COLLECTIONS FROM NATURAL AND ARTIFICIAL SUBSTRATES.
South Dakota State Univ., Brookings. Dept. of Wildlife and Fisheries.
For primary bibliographic entry see Field 5A.
W90-08697

POPULATION DYNAMICS AND FEEDING OF MAYFLY LARVAE IN SOME ACID AND ALKALINE NEW ZEALAND STREAMS.
Canterbury Univ., Christchurch (New Zealand).
Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W90-08698

EXPERIMENTAL EVIDENCE QUANTIFYING THE ROLE OF BENTHIC INVERTEBRATES

IN ORGANIC MATTER DYNAMICS OF HEADWATER STREAMS.
Georgia Univ., Athens. Dept. of Entomology.
For primary bibliographic entry see Field 2H.
W90-08702

ENZYMIC AND CHEMICAL ANALYSIS OF PARTICULATE ORGANIC MATTER FROM A BOREAL RIVER.
Clarkson Univ., Potsdam, NY. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-08703

PRODUCTION OF JUVENILE ATLANTIC SALMON, SALMO SALAR L., AND BROWN TROUT, SALMO TRUTTA L., WITHIN DIFFERENT SECTIONS OF A SMALL ENRICHED NORWEGIAN RIVER.
Rogaland Distriktshoegskole, Stavanger (Norway).
For primary bibliographic entry see Field 2H.
W90-08709

SUCCESSIONAL DYNAMICS OF THE PHYTOPLANKTON IN THE LOWER PART OF THE RIVER EBRO.
Barcelona Univ. (Spain). Dept. de Ecologia.
For primary bibliographic entry see Field 2H.
W90-08712

NUTRIENT CONCENTRATION-FLOW RELATIONSHIPS AND LOADS IN THE SOUTH PINE RIVER, SOUTH-EASTERN QUEENSLAND. I. PHOSPHORUS LOADS.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
For primary bibliographic entry see Field 2H.
W90-08727

BEHAVIOUR AND FLUXES OF COPPER AND LEAD IN THE NILE RIVER ESTUARY.
Alexandria Univ. (Egypt). Dept. of Oceanography.
For primary bibliographic entry see Field 5B.
W90-08735

DOWN BY THE RIVER: THE IMPACT OF FEDERAL WATER PROJECTS AND POLICIES ON BIOLOGICAL DIVERSITY.
For primary bibliographic entry see Field 6G.
W90-08746

PROCEEDINGS OF THE SYMPOSIUM ON HEADWATERS HYDROLOGY.
American Water Resources Association, Bethesda, Maryland. 1989. 708p. Edited by William W. Woessner and Donald F. Potts.

Descriptors: *Ecosystems, *Headwaters, *Headwaters hydrology, *Hydrology, *River mechanics, Conferences, Economic aspects, Instream flow, Public policy, River sediments, Sediment yield, Stream channels, Symposium, Water quality, Watershed management.

This symposium, convened in the headwaters of the Columbia River, is intended to be a forum for researchers to report on recent research and policy issues surrounding headwaters hydrology. Headwaters are a dynamic, hydrologic system where the physical and chemical reactions of the waters react with the biological systems of the earth. Over two-thirds of the papers submitted to the symposium address the workings of headwaters. Headwaters not only give birth to rivers, they also hold vast timber, mineral, wildlife, fish and recreation resources. However, this richness in resources often results in management conflicts which are resolved with varying degrees of success. Approximately one-third of the papers submitted for presentation address these issues. Over 70 papers, by authors from Guam, Canada, and over 20 states, describe the aspects of headwater hydrology in this proceedings. Section headings include: sediment yield evaluation; water policy and economics; riparian systems/management; instream flow;

stream channels; mining and sediment; cumulative watershed effects; water quality; and water yield and modeling. (See W90-08823 thru W90-08892) (Lantz-PTT)
W90-08822

FOUR-LEVEL HIERARCHY FOR ORGANIZING WILDLAND STREAM RESOURCE INFORMATION.
Forest Service, Milwaukee, WI.
H. Parrott, D. A. Marion, and R. D. Perkinson.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 41-54, 4 fig, 1 tab, 39 ref.

Descriptors: *Classification, *Data interpretation, *Headwaters hydrology, *Stream classification, *Streams, Flow pattern, Flow profiles, Flow velocity, Morphology, Riparian waters, Stream morphology, Streamflow.

An analysis of current USDA Forest Service methods of collecting and using wildland stream resource data indicates that required information can be organized into a four-level hierarchy. Information at each level is tiered with information at the preceding level. Level 1 is the ASSOCIATION, which is differentiated by stream size and flow regime. Level 2, STREAM TYPE, is differentiated by valley bottom materials and morphology, riparian ecosystem vegetation and channel gradient. Level 3 is the REACH, which is defined by hydraulic patterns, changes in flow volume, and substrate and bank composition. Level 4 is the HYDRAULIC UNIT, which is differentiated by water surface slope, low-flow constrictions, flow pattern, velocity and depth relative to reach average and water turbulence. Differentia for each level are measurable stream characteristics on which stream capability is dependent. The proposed hierarchy can reduce data costs, permit more accurate and precise resource evaluations, and allow local flexibility in information management. (See also W90-08822) (Author's abstract)
W90-08827

HYDROLOGY OF FOUR HEADWATER BASINS IN THE SIERRA NEVADA.
California Univ., Santa Barbara. Center for Remote Sensing and Environmental Optics.
For primary bibliographic entry see Field 2A.
W90-08838

RECENT TRENDS IN GLACIERS AND GLACIER RUNOFF, WIND RIVER RANGE, WYOMING.
Wyoming Univ., Laramie. Dept. of Geography and Recreation.
For primary bibliographic entry see Field 2C.
W90-08840

EFFECT OF A LOG-JAM BURST ON BEDLOAD TRANSPORT AND CHANNEL CHARACTERISTICS IN A HEADWATERS STREAM.
Montana Dept. of State Lands, Helena.
For primary bibliographic entry see Field 2J.
W90-08844

SUSPENDED SEDIMENT AND TURBIDITY FROM NORTHERN YELLOWSTONE PARK, WYOMING, 1985-1987.
Yellowstone National Park, WY. Research Div.
For primary bibliographic entry see Field 2J.
W90-08845

LETTING THE RIVERS RUN: TOWARD A MODEL INSTREAM FLOW PROGRAM.
Montana Dept. of Natural Resources and Conservation, Helena.
For primary bibliographic entry see Field 6A.
W90-08855

HYDROLOGIC ANALYSIS OF THE GULKANA NATIONAL WILD RIVER, ALASKA.
Bureau of Land Management, Lakewood, CO.

Minerals and Environmental Protection Staff.
D. A. Ellerbroek, W. A. Jackson, and B. P. Van Haveren.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 331-340, 2 fig, 7 tab, 8 ref.

Descriptors: *Forest hydrology, *Gulkana River, *Headwaters hydrology, *Instream flow, *Streamflow forecasting, *Water rights, Flood peak, Flow discharge, Flow profiles, Hydraulic geometry, Hydrologic properties, Hydrologic regime, Mathematical equations, Mathematical studies, Rainfall-runoff relationships, Runoff.

A hydrologic analysis was developed for the Gulkana River in south-central Alaska, as part of an instream flow water rights assessment prepared by the Bureau of Land Management. The hydrologic analysis was designed to quantify the natural flow regime within the Wild River corridor and develop relationships between discharge and flow attributes (width, depth, velocity, wetted perimeter, and cross-section area). The natural flow regime was quantified so that instream flow needs could be expressed as a percentage of normally occurring discharges. Hydraulic geometry relationships were developed to assist in evaluating the effects of alternative discharge rates on resource values. Since only eight years of flow records existed for the Gulkana River, regional analysis techniques, including synthetic discharge records developed through streamgage correlation and regional discharge formulae, were used to enhance the analysis. Discharge summaries were transposed to key resource use areas on the river using regional area-discharge relationships. Hydraulic geometry relations were developed at 33 field sites using Manning Equation methods. The Gulkana River is characterized by snowmelt-dominated runoff peaks in late May and June, though highly tempered, response to summer rainfall. The 100-year return period flood is only about three times the magnitude of the mean annual discharge peak. Runoff characteristics combine with the physiographic setting to create the Gulkana River's unique fluvial character. (See also W90-08822) (Author's abstract)
W90-08856

COARSE WOODY DEBRIS AND CHANNEL MORPHOLOGY OF LOW-GRADIENT STREAMS IN SOUTHEAST ALASKA, U.S.A.
Oregon State Univ., Corvallis. Dept. of Forest Engineering.
E. G. Robison, and R. L. Beschta.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 371-380, 5 fig, 2 tab, 12 ref.

Descriptors: *Channel morphology, *Detritus, *Headwaters hydrology, Alaska, Correlation analysis, Stream profiles.

Characteristics of coarse woody debris (CWD) and channel morphology were measured in five undisturbed low-gradient streams ranging in size from first-order to fourth-order. The average CWD length, diameter and volume per piece generally increased with stream size. CWD volumes, spacing, and position relative to the channel varied with stream size. Approximately 80% of the total CWD volume associated with the two smallest streams was positioned above or to the side of the stream, whereas only 40% of the total volume was similarly positioned in the largest stream. Autocorrelation analysis of stream depth and width data measured at equally spaced intervals along the channel indicated no significant periodicity in channel dimensions. Instream CWD volumes were correlated with variations in bankfull width but not with low-flow thalweg depth. CWD loadings and channel processes in undisturbed streams of different sizes provide an important perspective from which to evaluate the role of land use and stream management practices. (See also W90-08822) (Author's abstract)
W90-08860

SPATIAL AND SEASONAL PATTERNS OF STREAMBED WATER TEMPERATURES IN AN ALASKAN SUBARCTIC STREAM.
Alaska Univ., Fairbanks. Inst. of Arctic Biology.
J. G. Irons, S. R. Ray, L. K. Miller, and M. W. Oswood.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 381-390, 5 fig, 1 tab, 46 ref. NSF Grant BSR-8518681.

Descriptors: *Alaska, *Headwaters hydrology, *Seasonal variation, *Spatial distribution, *Streambeds, *Subarctic zone, *Water temperature, Monument Creek, Stream sediments, Surface-groundwater relations, Temperature.

Streambed temperature profiles were determined for two years (October 1986 to October 1988) in Monument Creek, a second order subarctic stream. Hourly temperature recordings were made at two vertical profiles (near-bank and mid-channel). Air temperatures ranged from -41.6 C to +22.5 C, (mean = 3.8 C). Streambed surface temperatures (as measured in mid-channel) ranged between -0.1 and 13.0 C (year one), and -12.8 to 12.7 C (year two). In the first winter, the near-bank streambed repeatedly froze and thawed during the winter, while the mid-channel streambed never froze. In spite of very cold air temperatures, the coldest temperature reached in frozen stream sediments was -2.5 C. However, in the second winter, both profiles remained frozen (minimum -12.8 C) for most of the winter, although stream flow was still present. Spatial and temporal patterns in water temperature were complex and indicated that streambed water was derived from both stream-water and groundwater. Amount of rain (especially in late fall) was correlated with the hydrology and temperature dynamics of the streambed. In years with late autumn rains, stream sediments may remain unfrozen through the winter as groundwater slowly discharges to the stream; in drier years, sediments may freeze deeply, with profound effects on the availability of unfrozen 'refugia' for overwintering stream invertebrates and immature fishes. (See also W90-08822) (Author's abstract)
W90-08861

VALIDATION AND SENSITIVITY ANALYSIS OF THE STREAM NETWORK TEMPERATURE MODEL ON SMALL WATERSHEDS IN NORTHEAST OREGON.
EA Engineering, Science, and Technology, Inc., Lafayette, CA.
B. L. Mattax, and T. M. Quigley.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 391-400, 1 fig, 3 tab, 13 ref.

Descriptors: *Headwaters hydrology, *Model studies, *Stream Network Temperature model, *Water temperature, Air temperature, Calibrations, Data interpretation, Oregon, Sensitivity analysis, Simulation analysis.

The Stream Network TEMPerature model (SNTEMP) developed by the Soil Conservation Service and the Fish and Wildlife Service was validated on 13 small mountain watersheds in Northeast Oregon. Watershed-specific and regional analyses were carried out for summer and fall weekly time periods. Calibration techniques were compared to determine the applicability and benefits of each. Data for seven watersheds randomly selected for watershed-specific analysis were divided into calibration and validation data subsets. Calibration was conducted by varying air temperature calibration factors to minimize two objective functions for the calibration subsets. Application of these calibration factors to validation data subsets within the same watershed resulted in mean errors ranging from -0.87 to 0.16 C. Average error was -0.21 C. Regional calibration factors were developed and applied to the six remaining watersheds. These watersheds displayed a mean error ranging from -0.84 to 0.37 C. Their average error was -0.32 C. Sensitivity analysis indicated that temperature simulations were highly sensitive to air temperature values. Accurate air temperature data for the

site under investigation would contribute greatly to the accuracy of SNTEMP. (See also W90-08822) (Author's abstract)
W90-08862

FACTORS INFLUENCING POOL MORPHOL-OGY IN OREGON COASTAL STREAMS.
Oregon State Univ., Corvallis. Dept. of Forest Engineering.
W. R. Stack, and R. L. Beschta.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 401-411, 6 fig, 1 tab, 19 ref.

Descriptors: *Channel morphology, *Coastal streams, *Forest watersheds, *Headwaters hydrology, *Oregon, Land management, Logging, Stream gradient, Stream restoration.

Pool morphology and related stream characteristics were surveyed along 14 stream sections in the central Oregon Coast Range; six of the upstream watersheds were undisturbed and the remaining eight had a low degree of timber harvesting (i.e., <20% of the area). Watershed areas and channel gradients ranged from 1.3 to 17.3 sq km and from 0.5 to 5.6%, respectively. Residual pool volumes and the number of residual pools were significantly (p<0.10) correlated to drainage area. Stream sections with beaver dams typically had relatively large pools. Processes associated with pool formation (e.g., plunge, deflection) were significantly correlated with the channel gradient; the direction of these correlations varied with the type of process. Certain elements associated with pool formation (i.e., woody debris and boulders) were significantly correlated with an index of total stream power; the percentage of wood-formed pools decreased as total stream power increased, whereas boulder-formed pools increased. These relationships may assist fisheries biologists and land managers in designing and evaluating stream rehabilitation projects and in assessing the effects of riparian management practices on pool morphology. (See also W90-08822) (Author's abstract)
W90-08863

CUMULATIVE HYDROLOGIC EFFECTS ON STORMFLOWS OF SUCCESSIVE CLEARCUTS ON A SMALL HEADWATER BASIN.
Pennsylvania State Univ., University Park. School of Forest Resources.
For primary bibliographic entry see Field 4C.
W90-08870

EFFECT OF A MAJOR WILDFIRE ON WATER QUALITY IN SOUTHEASTERN BRITISH CO-LUMBIA.
British Columbia Ministry of Forests, Nelson. Forest Science Section.
D. R. Gluns, and D. A. A. Toews.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 487-499, 6 fig, 4 tab, 28 ref.

Descriptors: *British Columbia, *Forest fires, *Forest watersheds, *Headwaters hydrology, *Stream pollution, *Water quality, Nitrates, Turbidity, Water supply.

Following the occurrence of a major wildfire in the headwaters of a watershed used as a domestic water supply, water quality was evaluated for three years. Water sampling stations established on two burned and one unburned tributaries measured differences between upstream and downstream concentrations of various water quality parameters, to assess the fire effects. Most notable was an increase in nitrate-nitrogen. Other parameters such as conductivity, total alkalinity, total hardness, calcium, magnesium, total nitrogen, total phosphorus and pH differed significantly between the burned and the unburned tributaries. The maximum difference in nitrate-nitrogen occurred immediately prior to second-year peak runoff, demonstrating a response noted in several other studies of water quality effected by wildfire. Although this fire produced detectable changes in water quality, with

the exception of true color and turbidity, other parameters did not exceed Canadian drinking water standards. (See also W90-08822) (Author's abstract)
W90-08871

ROLE OF ATMOSPHERIC DEPOSITION IN STREAMFLOW GENERATION AND EPISOD-IC WATER QUALITY.
Vermont Univ., Burlington.
For primary bibliographic entry see Field 5B.
W90-08875

STRATIFIED FLOOD FREQUENCY ANALY-SIS.
State Univ. of New York Coll. of Environmental Science and Forestry, Syracuse.
P. E. Black.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 563-572, 1 fig, 1 tab, 20 ref.

Descriptors: *Flood frequency, *Frequency analysis, *Headwaters hydrology, *Hydrologic properties, *Runoff, Drainage area, Snowmelt, Storms, Watersheds.

Three pairs of watersheds were subjected to repeated log-normal flood frequency analyses on their partial duration series for coincident periods of record. For each watershed, log-normal curves were determined for the three hydrologic seasons, presuming seasonal distribution of the three different types of runoff-causing events. Variation about the flood frequency curve can be reduced, but not on all the pairs selected and, therefore, not on all watersheds. The results are drainage area-dependent, and may be affected by other characteristics of the hydrographic region, as well. (See also W90-08822) (Author's abstract)
W90-08878

HYDROLOGIC PRODUCTION ZONES IN A HEADWATER WATERSHED.
Northeastern Forest Experiment Station, University Park, PA.
E. S. Corbett, and J. A. Lynch.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 573-578, 5 tab, 4 ref.

Descriptors: *Antecedent moisture, *Headwaters, *Headwaters hydrology, *Hydrologic properties, *Rainfall-runoff relationships, *Storm runoff, Experimental basins, Forest watersheds, Pennsylvania, Soil water.

To investigate the hydrologic behavior and response of a small forested watershed, an irrigation system was designed to apply simulated rainfall to parts or all of a 19.59 acre experimental watershed in central Pennsylvania. Storm applications of 0.96 inch were made at both dry and wet antecedent soil moisture conditions. Under dry antecedent soil moisture conditions the rising limb and hydrograph peak are produced by stormflow contributions from the channel and base slope zones, primarily in the front 30% of the watershed. The percent of rainfall concerted into quickflow ranged from 21.9% for the channel-base slope application to 9.8% for the total watershed application. Under wet antecedent soil moisture conditions the percent of rainfall converted into quickflow ranged from 55.9% for the channel application to 82.6% for the channel-lower slope application. (See also W90-08822) (Author's abstract)
W90-08879

DEFINING HYDROLOGIC CHARACTERIS-TICS OF HEADWATERS FORESTED WATER-SHEDS IN THE SOUTHERN INTERIOR OF BRITISH COLUMBIA.
British Columbia Ministry of Forests, Kamloops.
For primary bibliographic entry see Field 2A.
W90-08880

ESTIMATING MEAN MONTHLY STREAM-FLOW AT UNGAGED SITES IN WESTERN MONTANA.
Geological Survey, Helena, MT.
For primary bibliographic entry see Field 7C.
W90-08881

HYDROLOGIC SIMULATION TECHNIQUES APPLIED TO WATER MANAGEMENT IN MONTANA.
Montana Dept. of Natural Resources and Conservation, Helena.
S. R. Holnbeck, and S. K. Sando.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 599-608, 9 fig, 13 ref.

Descriptors: *Headwaters hydrology, *Hydrologic models, *Model studies, *Montana, *Simulation analysis, *Water resources management, Case studies, Computer models, Flint Creek, Milk River, Rock Creek.

Water resources investigations often require development of a computer simulation model to evaluate interactive elements of the study basin. In Montana, modeling of basins with complex interactions of water supply and water demand is often complicated by a general paucity of data. Typically, however, techniques can be applied that allow reasonable solutions even when data are not extensive. Three case studies demonstrate the application of modeling to complex basins in Montana. The basins are Flint Creek, Rock Creek, and Milk River, representing headwaters of three major river basins of Montana--the Clark Fork, Yellowstone, and Missouri. Models developed in these studies were designed to represent hydrologic regimes of the basins and include such parameters as irrigation diversions and return flows, reservoir operations, instream flows, proposed future water allocations, and other consumptive and nonconsumptive uses. The studies illustrate application of simulation techniques under conditions varying with respect to complexity of the basins, availability of pertinent data, and objectives of the analysis. Model verification comparing simulated to actual streamflows is presented. (See also W90-08822) (Author's abstract)
W90-08882

MODELING RUNOFF FROM SAGEBRUSH RANGELANDS ALONG A CLIMATIC GRADI-ENT IN SOUTHWEST IDAHO.
Agricultural Research Service, Boise, ID. Northwest Watershed Research Center.
B. P. Wilcox, M. S. Seyfried, K. R. Cooley, and C. L. Hanson.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 609-618, 5 fig, 1 tab, 16 ref.

Descriptors: *Climatic zones, *Headwaters hydrology, *Hydrologic models, *Idaho, *Model studies, *Runoff forecasting, Annual runoff, Frost, Rainfall-runoff relationships, Runoff volume, Rural areas, Simulation analysis, Simulator for Water Resources in Rural B, Snowmelt.

Precipitation-runoff relationships on five sagebrush watersheds occurring along a climatic gradient in southwestern Idaho were established using 8-25 years of record. Runoff was simulated from four of the five watersheds using SWRRB (Simulator for Water Resources in Rural Basins). Runoff from the two higher elevation watersheds is snowmelt generated. With decreasing elevation soil frost plays a much larger role in runoff generation. Average annual runoff ranged from about 1 mm to over 500 mm. The correlation between annual precipitation and annual runoff decreased with aridity of the watershed. SWRRB successfully simulated annual runoff volume from the highest elevation watershed where (1) runoff made up a high percentage (50%) of the water budget, (2) frozen soil runoff was insignificant, and (3) there was a strong correlation between annual runoff and precipitation. Runoff simulations were much less successful for

the lower elevation watersheds where: (1) runoff was a much smaller part (1-7%) of the water budget, (2) frozen soil runoff was very important, and (3) there was a poor correlation between annual runoff and precipitation. For sagebrush rangeland in the Great Basin, little confidence can be placed in runoff predicted from models, like SWRRB, that are based on curve number hydrology if runoff accounts for a small part (<10%) of the water budget and/or soil frost plays a prominent role in runoff generation. (See also W90-08822) (Author's abstract)
W90-08883

RECHARGE/DISCHARGE RELATIONSHIPS IN A COARSE-GRAINED ALLUVIAL AQUIFER.
IEP, Inc., Sandwich, MA.
For primary bibliographic entry see Field 2A.
W90-08892

WHY IS THE STREAM FAUNA OF SOUTHWESTERN AUSTRALIA SO IMPOVERISHED.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
For primary bibliographic entry see Field 2H.
W90-08902

KINEMATIC OVERLAND FLOW MODEL TO DETERMINE DEPRESSION STORAGE OF TILLED SURFACES.
Agricultural Univ., Wageningen (Netherlands). Dept. of Land and Water Use.
J. L. M. P. De Lima, L. A. A. J. Eppink, and W. H. Van der Molen.
Soil and Tillage Research SOTRD5, Vol. 15, No. 1/2, p 65-78, December 1989. 8 fig, 20 ref.

Descriptors: *Depression storage, *Flow models, *Hydrologic models, *Model studies, *Overland flow, *Tillage, Flow profiles, Infiltration, Mathematical models, Rainfall, Slope gradient.

A method based on the kinematic flow approximation to overland flow on a plane is developed to predict depression storage of tilled surfaces. In the laboratory, only the aspects of tillage, rainfall intensity and slope were investigated. The following impermeable models, simulating various tillage techniques, were used: plastic corrugations; concrete ridges; concrete mounds; and a concrete plane surface as a reference. The experiments were repeated for each tillage model with different slopes (varying from 0.5% to 4%), and for each slope with different rainfall intensities (varying from 0.009 to 0.109 mm/sec). The method was verified by comparing predicted depression storage with depression storage obtained from water-balance considerations based on the experimental data. It is believed that the model can be used to estimate spatial average depression storage if infiltration is known. (Author's abstract)
W90-08915

WATER QUALITY IN SOUTHEASTERN MINNESOTA STREAMS: OBSERVATIONS ALONG A GRADIENT OF LAND USE AND GEOLOGY.
Minnesota Univ., St. Paul. Dept. of Forest Resources.
For primary bibliographic entry see Field 4C.
W90-08970

FISHERY RESOURCE OF THE UPPER MISSISSIPPI RIVER AND RELATIONSHIP TO STREAM DISCHARGE.
Wisconsin Univ.-Superior. Center for Lake Superior Environmental Studies.
For primary bibliographic entry see Field 8I.
W90-08992

DEVELOPMENT OF OPERATING RULES FOR THE VUOKSI RIVER BASIN.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 6A.
W90-09027

SNOW COVER AND SNOWMELT RUNOFF MODEL IN THE FOREST ZONE.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2C.
W90-09028

ATTEMPT TO EXPLAIN AND QUANTIFY FLUVIAL MORPHOLOGICAL PROCESSES BEGINNING WITH THE REGIME THEORY (ESSAI D'EXPLICATION ET DE QUANTIFICATION DES MORPHOLOGIES FLUVIALES A PARTIR DE LA THEORIE DE REGIME).
For primary bibliographic entry see Field 2J.
W90-09057

CONFERENCE ON CLIMATE AND WATER. VOLUME 2.
For primary bibliographic entry see Field 2A.
W90-09088

IMPACT OF PRECIPITATION VARIABILITY ON THE QUALITY OF RUNNING WATERS.
Uppsala Univ. (Sweden). Dept. of Hydrology.
For primary bibliographic entry see Field 5B.
W90-09090

FLOOD POTENTIAL, AN UNCERTAIN ESTIMATE RESULTING FROM CLIMATIC VARIABILITY AND CHANGE.
Hydrographisches Zentralbuero, Vienna (Austria).
For primary bibliographic entry see Field 2A.
W90-09109

STATE-SPACE MODEL FOR HYDROLOGIC RIVER ROUTING.
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
A. P. Georgakakos, K. P. Georgakakos, and E. A. Baltas.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 827-838, May 1990. 9 fig, 4 tab, 32 ref, 2 append. U.S. Geological Survey Grant 14-08-0001-G1297 and U.S. Army Corps of Engineer Grant DACW21-88-C-0043.

Descriptors: *Flood routing, *Model studies, *Rivers, Channel flow, Channel morphology, DWOPER model, Flood peak, Hydrographs, Mathematical models, Muskingum-Cunge model, River flow.

A state-space formulation of the Muskingum-Cunge routing scheme uses real-time discharge measurements, accounts for modeling and observation errors, and allows real-time updating through a Kalman filter estimator. The model was used to forecast 6-hour discharge values in two types of hypothetical channels: sandy channels with mild slopes and coarse noncohesive channels with steep slopes. For realism, the geomorphologic characteristics were determined on the basis of the regime theory. A numerical dynamic routing model, DWOPER, was used to provide ground truth data for validation of the model. Utilizing the flow measurements improved the predictive ability of the Muskingum-Cunge routing scheme, especially in channels with mild slopes. Adjusting the slope of the Muskingum-Cunge model drastically improved model performance and forecasting ability in flat slopes. This adjustment was performed using maximum likelihood estimation methods and was found to be independent of the hydrograph shape. (Cassar-PTT)
W90-09157

FRACTAL INTERPRETATION OF THE MAINSTREAM LENGTH-DRAINAGE AREA RELATIONSHIP.
Montreal Univ. (Quebec). Dept. of Geography.
A. Robert, and A. G. Roy.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 839-842, May 1990. 1 fig, 3 tab, 21 ref.

Descriptors: *Channel morphology, *Drainage area, *Fractal geomorphology, *Geomorphology, *Mapping, *Rivers, Basins, Catchment basins, Eaton River, Fractal quantities, Hydrologic maps, Maps, Morphology, Quebec, River basins, Topographic mapping.

The exponent of the mainstream length-drainage area relationship was interpreted as a fractal quantity, superseding the previous allometric interpretation. The fractal interpretation was based on the assumption that cartographic generalization was evenly applied to all map scales. Twenty-three drainage basins of the Eaton River (Quebec, Canada) were delineated from topographic maps at three different scales (1:20,000, 1:50,000 and 1:125,000). The exponent of the length-area relation was much lower (0.546) at the largest scale than at the smallest scales (0.65), and its value corresponded to that obtained from a Richardson analysis of 10 interior stream segments. At the 1:20,000 map scale, the exponent was entirely fractal. The larger exponent values obtained at the smallest scales exceeded the fractal value and incorporated an allometric component. This component was not functional, however; and it merely reflected the generalization process of cartographic abstraction of stream heads as scale was reduced. It was concluded that the fractal dimension of streams should not be inferred from the exponent of the length-area relation because of possible scale-dependency. (Author's abstract)
W90-09158

PERIODIC COVARIANCE STATIONARITY OF MULTIVARIATE PERIODIC AUTOREGRESSIVE MOVING AVERAGE PROCESSES.
Middle East Technical Univ., Ankara (Turkey). Dept. of Statistics.
For primary bibliographic entry see Field 7C.
W90-09160

CHARACTERIZATION OF TRANSPORT IN AN ACIDIC AND METAL-RICH MOUNTAIN STREAM BASED ON A LITHIUM TRACER INJECTION AND SIMULATIONS OF TRANSIENT STORAGE.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 5B.
W90-09171

SNOWMELT RUNOFF MODELING IN A BALSAM FIR FOREST WITH A VARIABLE SOURCE AREA SIMULATOR (VSAS2).
Laval Univ., Quebec. Lab. d'Hydrologie Forestiere.
For primary bibliographic entry see Field 2C.
W90-09177

APPLICATION OF A SNOW COVER ENERGY AND MASS BALANCE MODEL IN A BALSAM FIR FOREST.
Laval Univ., Quebec. Lab. d'Hydrologie Forestiere.
For primary bibliographic entry see Field 2C.
W90-09178

GENERALIZED DIFFUSION WAVE EQUATION WITH INERTIAL EFFECTS.
San Diego State Univ., CA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-09180

OVERLAND FLOW IN WETLANDS: VEGETATION RESISTANCE.
Michigan Univ., Ann Arbor. Dept. of Chemical Engineering.
R. H. Kadlec.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 5, p 691-706, May 1990. 9 fig, 1 tab, 19 ref.

Descriptors: *Flow, *Hydraulics, *Overland flow, *Vegetation effects, *Wetlands, Aquatic plants, Channel flow, Flow velocity, Friction, Macrophytes, Mathematical studies, Model studies, Open-channel flow, Slopes, Submerged plants, Surface flow, Turbulent flow, Vegetation.

Group 2E—Streamflow and Runoff

A model for describing overland flow in wetlands with emergent vegetation was developed. It involves a simple power law equation for dense emergent vegetation with spatial uniformity on the scale of 10 m. Parameters may be estimated from vegetation and soil surveys; relatively little hydrologic data is needed. The model overcomes the problems resulting from application of equations such as the Manning equation, which was developed for fully turbulent flow in open channels with modifications for bottom-surface roughness. Vegetation-density profiles were measured for the sedge cover type at Houghton Lake, Michigan. The vegetation frontal area was large in the litter layer, decreasing to zero at the top of the canopy. The vegetation resistance dropped exponentially at the rate of about a factor of 10 for each 30-40 cm increase in depth over the first meter. Cassar-PTT) W90-09191

CHARACTERISTICS OF SELF-FORMED STRAIGHT CHANNELS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
P. Diplas.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 5, p 707-728, May 1990. 10 fig, 1 tab, 29 ref. U.S. Environmental Protection Agency Contract R-808683-01-1 and National Science Foundation Grant CTS-8909984.

Descriptors: *Alluvial channels, *Channel flow, *Channel morphology, *Hydraulics, Banks, Bed load, Flow velocity, Flumes, Morphology, Sediment transport, Shear stress, Straight channels, Stream banks, Threshold channel, Turbulent flow.

Laboratory flume experiments were conducted in a study of the mechanics of self-formed, stable, straight alluvial channels in the presence of bedload transport. Straight channel flow was described better by the turbulent-diffusion model of Parker than by the threshold-channel model. Velocity measurements indicated that the logarithmic law for rough walls was a valid approximation to the velocity profile, along normals to the boundary for the whole channel depth. The equivalent sand-grain roughness was about 2d90. Regime relations based on the straight-channel model and a resistance equation accurately predicted the center depth and the top width of a self-formed straight channel. The shape of the bank closely followed an empirically fitted exponential function dependent only upon the center-channel depth. Experimental results were in good agreement with available field and laboratory data. (Cassar-PTT) W90-09192

DESTRUCTION OF SPAWNING GROUNDS OF MAHSEER AND OTHER FISH IN GARHWAL HIMALAYAS.
Garhwal Univ., Srinagar (India). Dept. of Zoology.
For primary bibliographic entry see Field 4C. W90-09194

MAHSEER CONSERVATION: PROBLEMS AND PROSPECTS.
Garhwal Univ., Srinagar (India). Dept. of Zoology.
For primary bibliographic entry see Field 2H. W90-09195

PLANT PIGMENTS AS TRACERS OF EMERGENT AND SUBMERGENT MACROPHYTES FROM THE HUDSON RIVER.
New York Botanical Garden, Bronx, NY. Inst. of Ecosystem Studies.
For primary bibliographic entry see Field 7B. W90-09234

STORAGE AND DYNAMICS OF SUBSURFACE DETRITUS IN A SAND-BOTTOMED STREAM.
Virginia Commonwealth Univ., Richmond. Dept. of Biology.
For primary bibliographic entry see Field 2H. W90-09238

VARIATION IN DIATOM COMMUNITY STRUCTURE AMONG HABITATS IN SANDY STREAMS.
Louisville Univ., KY. Dept. of Biology.
For primary bibliographic entry see Field 2H. W90-09246

EFFECTS OF IMPOUNDMENT ON THE PHYSICOCHEMISTRY OF TWO CONTRASTING SOUTHERN AFRICAN RIVER SYSTEMS.
Rhodes Univ., Grahamstown (South Africa). Inst. of Freshwater Studies.
For primary bibliographic entry see Field 6G. W90-09248

INTERACTIONS BETWEEN GEOMORPHOLOGICAL PROCESSES, BENTHIC AND HYPORHEIC COMMUNITIES: FIRST RESULTS ON A BY-PASSED CANAL OF THE FRENCH UPPER RHONE RIVER.
Lyon-1 Univ., Villeurbanne (France). Lab. d'Hydrobiologie et Ecologie Souterraines.
For primary bibliographic entry see Field 2H. W90-09251

ELEMENT TRANSPORT IN REGULATED AND NON-REGULATED RIVERS IN NORTHERN SWEDEN.
Umea Univ. (Sweden). Dept. of Physical Geography.
L. Brydsten, M. Jansson, T. Andersson, and A. Nilsson.
Regulated Rivers Research & Management RRRMEP, Vol. 5, No. 2, p 167-176, March/May 1990. 3 fig, 5 tab, 9 ref.

Descriptors: *Dam effects, *Nutrients, *Organic matter, *Rivers, *Sediment transport, *Sweden, *Water chemistry, Calcium, Carbonates, Chemical properties, Chlorides, Iron, Magnesium, Manganese, Nitrates, Nitrites, Nitrogen, Particulate matter, Phosphorus, Potassium, Reservoirs, River flow, Runoff, Sedimentation, Silica, Sodium, Stream erosion, Sulfates.

The transport of $HCO_3(-)$, $SO_4(2-)$, $Cl(-)$, $Ca(2+)$, $Mg(2+)$, $Na(+)$, $K(+)$, total-P, MRP, total-N, NO_3-N, NO_2-N, NH_4-N, Fe, Mn, silica, particulate material, and organic material (total and dissolved) were compared in three rivers regulated for the exploitation of hydroelectric power and in three unregulated rivers in northern Sweden. This evaluation was done by statistical analysis of data derived from monthly sampling near the outlets of the rivers during the period 1972-1986. Significant differences due to regulation were found for particulate matter, total-P, Fe, and silica. Regulation decreased the transport by 10-50%, depending on the parameter and the river. The explanations for this effect are sedimentation of particles in impoundments and decreased erosion of the river bed due to the elimination of runoff during the snow melt period. The reduced transport of phosphorus may affect the productivity of the coastal zone of Bothnian Bay into which the rivers discharge. (Author's abstract) W90-09253

TRANSPORT OF MAJOR SOLUTES AND THE RELATIONSHIP BETWEEN SOLUTE CONCENTRATIONS AND DISCHARGE IN THE APURE RIVER, VENEZUELA.
Colorado Univ. at Boulder. Center for Limnology.
J. F. Saunders, and W. M. Lewis.
Biogeochemistry BIOGEP, Vol. 8, No. 2, p 101-113, September 1989. 1 fig, 5 tab, 27 ref. NSF Grants DEB8116725, BSR8315410, and BSR8604655.

Descriptors: *Apure River, *Solute transport, *Stream discharge, *Venezuela, *Water chemistry, Bicarbonates, Calcium, Chlorides, Ions, Magnesium, Model studies, Orinoco River, Silicon, Sodium, Sulfates.

The Apure River is a major white-water tributary of the Orinoco River in Venezuela. The Apure is rich in solutes; its contribution to dissolved inorganic solids in the Orinoco (24%) is proportionately much greater than its contribution to discharge (6%). About 40% of the calcium and bicarbonate at the mouth of the Orinoco originate in the Apure drainage. The relationship between discharge and the concentrations of major solutes in the Apure was characterized with a two-compartment hyperbolic mixing model. Previous applications of the two-compartment model have been based on separate determinations of the model parameter beta, which is a constant describing watershed hydrology, for each solute from data on concentrations. The use of a weighted mean beta for all solutes is proposed as a means of assessing the importance of processes other than mixing. The model, when used on the Apure data, shows that a strong dilution effect prevails for sodium, calcium, magnesium, sulfate, and bicarbonate, and that a strong purging effect (increase of concentration with increasing discharge) is characteristic of soluble silicon. Biological immobilization of soluble silicon by diatoms during the season of low discharge is sufficiently large to account for the positive relationship between discharge and the concentration of soluble silicon. Specific transport rates of solutes from the basin are generally higher than global averages. In contrast, specific transport of chloride is low. Atmospheric sources control chloride transport in the Apure watershed; the low transport rates of chloride are probably explained by the great distance between the Apure watershed and the oceanic sources of atmospheric chloride. (Author's abstract) W90-09264

COMPARISON OF NITRIFICATION RATES IN THREE BRANCHES OF THE LOWER RIVER RHINE.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5B. W90-09266

ANTIBIOTIC RESISTANCE OF SALMONELLA STRAINS ISOLATED FROM NATURAL POLLUTED WATERS.
Malaga Univ. (Spain). Dept. of Microbiology.
For primary bibliographic entry see Field 5B. W90-09274

GEOCHEMISTRY OF DISSOLVED PHOSPHATE IN THE SEPIK RIVER AND ESTUARY, PAPUA, NEW GUINEA.
Harvard Univ., Cambridge, MA. Dept. of Earth and Planetary Sciences.
For primary bibliographic entry see Field 2K. W90-09293

GENERALIZED LOW-FLOW FREQUENCY RELATIONSHIPS FOR UNGAGED SITES IN MASSACHUSETTS.
Tufts Univ., Medford, MA. Dept. of Civil Engineering.
R. M. Vogel, and C. N. Kroll.
Water Resources Bulletin WARBAQ, Vol. 26, No. 2, p 241-253, April 1990. 2 fig, 4 tab, 22 ref.

Descriptors: *Least squares method, *Low flow, *Massachusetts, *Model studies, *Streamflow forecasting, Data interpretation, Mathematical models, Streamflow data, Ungaged sites.

Regional hydrologic procedures such as generalized least squares regression and streamflow record augmentation have been advocated for obtaining estimates of both flood-flow and low-flow statistics at ungaged sites. While such procedures are extremely useful in regional flood-flow studies, no evaluation of their merit in regional low-flow estimation has been made using actual streamflow data. Generalized regional regression equations were developed for estimating the d-day, T-year low-flow discharge, Qd,T, at ungaged sites in Massachusetts where d = 3, 7, 14, and 30 days. A two-parameter lognormal distribution was fit to sequences of annual minimum d-day low-flows and the estimated parameters of the lognormal distribution were then related to two drainage basin characteristics: drainage area and relief. The resulting

models are general, simple to use, and about as precise as most previous models that only provide estimates of a single statistic such as Q7,10. Comparisons are provided of the impact of using ordinary least squares regression, generalized least squares regression, and streamflow record augmentation procedures to fit regional low-flow frequency models in Massachusetts. (Author's abstract)
W90-09348

GROUND WATER FLOW AND RUNOFF IN A COASTAL PLAIN STREAM.
South Carolina State Coll., Orangeburg. Dept. of Natural Sciences.
For primary bibliographic entry see Field 2A.
W90-09358

MATHEMATICAL MODELING OF THE COMBINED SEWER SYSTEM.
Syracuse Univ., NY. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 7C.
W90-09377

HERBICIDE CONCENTRATION PATTERNS IN RIVERS DRAINING INTENSIVELY CULTIVATED FARMLANDS OF NORTHWESTERN OHIO.
Heidelberg Coll., Tiffin, OH. Water Quality Lab.
For primary bibliographic entry see Field 5B.
W90-09448

PESTICIDES IN RUNOFF FROM FORESTED LANDS IN THE SOUTHEAST.
Georgia Univ., Athens. Cooperative Extension Service.
For primary bibliographic entry see Field 5B.
W90-09456

COPPER, CHROMIUM, ARSENIC AND PENTACHLOROPHENOL CONTAMINATION OF A SOUTHERN APPALACHIAN FOREST STREAM.
Southeastern Forest Experiment Station, Gainesville, FL.
For primary bibliographic entry see Field 5B.
W90-09458

MOVEMENT OF TRIAZINE HERBICIDES IN CONVENTIONAL AND CONSERVATIVE TILLAGE SYSTEMS.
Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W90-09467

IMPACT OF CONSERVATION TILLAGE AND PESTICIDE USE ON WATER QUALITY: RESEARCH NEEDS.
North Carolina State Univ., Raleigh. Dept. of Biological and Agricultural Engineering.
For primary bibliographic entry see Field 4C.
W90-09469

2F. Groundwater

TRIHALOMETHANES IN THE WATER SUPPLIES OF SARDINIA, ITALY.
Cagliari Univ. (Italy). Inst. of Hygiene.
For primary bibliographic entry see Field 5B.
W90-08664

COMPLEXATION-ADSORPTION MODEL DESCRIBING THE INFLUENCE OF DISSOLVED ORGANIC MATTER ON THE MOBILITY OF HYDROPHOBIC COMPOUNDS IN GROUNDWATER.
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
For primary bibliographic entry see Field 5B.
W90-08673

MOBILITY OF SOLUBLE AND NON-SOLUBLE HYDROCARBONS IN CONTAMINATED AQUIFER.
Institut Francais du Petrole, Rueil-Malmaison.
For primary bibliographic entry see Field 5B.
W90-08675

BASIC STUDY ON TCES BEHAVIOR IN SUBSURFACE ENVIRONMENT.
Osaka Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-08681

MINERAL SAND MINING AND ITS EFFECT ON GROUNDWATER QUALITY.
Hunter District Water Board, Newcastle (Australia). Water Investigation and Planning Section.
For primary bibliographic entry see Field 5B.
W90-08683

GROUND WATER MODELING IN MULTI-LAYER AQUIFERS: UNSTEADY FLOW.
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
M. M. Aral.
Lewis Publishers, Inc., Chelsea, Michigan. 1990. 143p. Includes two 5-1/4-inch floppy diskettes with the computer programs discussed in the text.

Descriptors: *Aquifer systems, *Computer models, *Groundwater movement, *Model studies, *Unsteady flow, Aquifers, Computer programs, Finite element method, Mathematical models, Mathematical studies.

A computational management tool is presented and discussed which was designed for use by geohydrologists, engineers, geologists, educators, and students is presented. The software is suitable for implementation on microcomputers for the analysis of unsteady flow in multilayer aquifers. Unsteady flow in a typical multilayer aquifer system may be generated in response to time-dependent pumping operations from well networks distributed in the multilayer aquifer system or may be developed within the system in response to time-dependent aquifer boundary conditions. The multilayer aquifer computer program discussed is called the Unsteady Layered Aquifer Model (ULAM.EXE). The distribution disk accompanying this text also contains several data files for case studies discussed in the text and a BASIC program (IDEAL.BAS), which may be used to plot the finite-element idealization of the aquifer under study. Procedures to implement these codes are explained in detail in the text. Throughout the text, emphasis has been placed on practice and applications rather than on theory and mathematical rigidity. A data file input format, rather than a menu-operated screen input format, is used to facilitate problem definition and accuracy of data input. Output from the computer code is arranged in an easy-to-follow format and is stored in output data files. These output data files may later be printed out, viewed on the screen, or utilized as input data files for commercially available plotting routines for contour plotting or surface plotting of numerical results, as demonstrated in the book. (Lantz-PTT)
W90-08750

GROUNDWATER REMEDIATION AND PETROLEUM: A GUIDE FOR UNDERGROUND STORAGE TANKS.
Camp, Dresser and McKee, Inc., Boston, MA.
For primary bibliographic entry see Field 5G.
W90-08752

MICROBIOLOGY OF SUBSURFACE ENVIRONMENT: PRELIMINARY STATEMENT OF RESEARCH GOALS AND ABSTRACTS OF CURRENT RESEARCH.
Department of Energy, Washington, DC. Office of Health and Environmental Research.
For primary bibliographic entry see Field 5G.
W90-08753

MOBILITY AND DISTRIBUTION OF SELENIUM AND SALINITY IN GROUNDWATER AND

SOIL OF DRAINED AGRICULTURAL FIELDS, WESTERN SAN JOAQUIN VALLEY OF CALIFORNIA.
Geological Survey, Sacramento, CA.
For primary bibliographic entry see Field 5B.
W90-08756

GROUNDWATER CONTRIBUTIONS IN AN ALPINE BASIN IN THE SIERRA NEVADA.
California Univ., Santa Barbara. Santa Barbara Remote Sensing Unit.
R. Kattelmann.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 361-369, 3 fig, 1 tab, 23 ref. California Air Resources Board Contract A3-106-32 and A6-147-32.

Descriptors: *Alpine regions, *California, *Geohydrology, *Groundwater resources, *Headwaters hydrology, *Sierra Nevada Mountains, *Surface-groundwater relations, Groundwater discharge, Hydrologic regime, Kaweah River, Water chemistry.

A detailed study of the hydrology and hydrochemistry of a small alpine basin in the headwaters of the Kaweah River, California was conducted from 1984 to 1988. The study area is a typical granitic cirque with an elevation range of 2800 to 3400 m. More than one-third of the basin area is exposed bedrock, and almost all of the remainder is solid rock covered by a thin mantle of talus, colluvium, or poorly developed soils. Groundwater storage and release account for only a small portion of the total quantity of water in the annual water balance of the basin. However, subsurface water is very important in the temporal distribution of water. Releases from subsurface storage are the primary water input to the stream and lake system for eight to nine months of the year. Although the quantity of this water is small compared to snowmelt runoff, groundwater discharged from various deposits and fractures has the potential to control lake chemistry for more than two-thirds of the year. (See also W90-08822) (Author's abstract)
W90-08859

MIGRATION OF RADIONUCLIDES IN THE GROUNDWATER SYSTEM FROM RESIDUAL WASTES IN A URANIUM MINE.
Weston (Roy F.), Inc., West Chester, PA.
For primary bibliographic entry see Field 5B.
W90-08888

POTENTIAL SOURCES OF GROUNDWATER CONTAMINATION IN THE HEADWATERS OF THE MAHANTANGO CREEK.
Agricultural Research Service, University Park, PA. Northeast Watershed Research Center.
For primary bibliographic entry see Field 5B.
W90-08889

USE OF A HYDRAULIC POTENTIOMANOMETER TO DETERMINE GROUND-WATER GRADIENTS IN A WETLAND, COLORADO.
Geological Survey, Denver, CO.
B. C. Ruddy.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 675-683, 6 fig, 1 tab, 3 ref.

Descriptors: *Colorado, *Groundwater movement, *Headwaters hydrology, *Hydraulic potentiomanometer, *Streamflow, *Surface-groundwater relations, *Wetlands, Colorado River Basin, Data acquisition, Hydraulic head, Instrumentation, Measuring instruments, Stream morphology.

A series of three wetlands adjacent to the South Fork Williams Fork of the Colorado River in Grand County, Colorado, were studied to determine the relations between streamflow and groundwater in the wetlands. Initially, water level and water chemistry data from cross sections of wells were used to determine the direction of groundwater flow within the wetlands, and be-

tween the wetlands and the stream. At two wetlands, groundwater gradients were consistently from the wetlands toward the stream. At a third wetland, the data from one of the cross sections located in a stream meander lobe were inconclusive. Groundwater chemistry also was variable within the wetland and did not indicate flow direction. A hydraulic potentiomanometer, which measures point values of the difference in hydraulic head between groundwater and surface water, was used to make a detailed study of groundwater gradients in part of this wetland. The data indicated that groundwater was flowing across the meander lobe, approximately parallel to the stream. At the upstream end of the wetland, the gradient was consistently from the stream toward the wetland, and at the downstream end of the wetland, the gradient was consistently from the wetland toward the stream. Use of the hydraulic potentiomanometer enabled collection of data without construction of monitoring wells. (See also W90-08822) (Author's abstract)
W90-08890

ARSENIC CONTAMINATION OF AQUIFERS CAUSED BY IRRIGATION WITH DILUTED GEOTHERMAL WATER.
Montana Bureau of Mines and Geology, Butte.
For primary bibliographic entry see Field 5B.
W90-08891

RECHARGE/DISCHARGE RELATIONSHIPS IN A COARSE-GRAINED ALLUVIAL AQUIFER.
IEP, Inc., Sandwich, MA.
For primary bibliographic entry see Field 2A.
W90-08892

BACTERIOLOGICAL QUALITY OF PRIVATE WATER WELLS IN CLARK COUNTY, ARKANSAS.
Henderson State Univ., Arkadelphia, AR. Dept. of Biology.
For primary bibliographic entry see Field 5B.
W90-08913

SPRINGS OF VIRGINIA REVISITED: A COMPARATIVE ANALYSIS OF THE CURRENT AND HISTORICAL WATER-QUALITY DATA.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Water Resources Research Center.
L. A. Helfrich, D. L. Weigmann, K. W. Nutt, and R. M. Sterrett.
Virginia Journal of Science VJSCAI, Vol. 41, No. 1, p 14-27, Spring 1990. 1 fig, 3 tab, 16 ref.

Descriptors: *Groundwater quality, *History, *Spring water, *Springs, *Virginia, *Water quality, Bicarbonates, Calcium, Chemical analysis, Chlorides, Dissolved solids, Hardness, Infiltration, Nitrates, Seasonal variation, Sodium, Sulfates, Water temperature.

Physicochemical analyses of 31 springs in Virginia, previously sampled in 1928, were compared with current (post-1952) data collected at identical sites. This study examined the potential long-term trends in the physical and chemical constituents of spring waters. Water quality variability (within-spring variation), expressed as the percent coefficient of variation (% CV) over the study period was relatively high for: nitrate, 70% CV; sodium, 57% CV; sulfate, 42% CV; and chloride ions, 40% CV; but moderate for calcium, 22% CV; hardness, 19% CV; bicarbonate, 18% CV; and dissolved solids, 15% CV. Variation in water temperatures was minor, averaging less than 3% CV. Spring discharge fluctuated considerably, ranging from 3 to 95% CV and averaging 37% CV. Although the chemical content of most springs examined has remained relatively consistent for more than 60 years, increasing concentrations of nitrate, chloride, and total dissolved solids in some springs indicated a modest degree of pollution, perhaps resulting from surface contaminant infiltration. No notable trend in sodium and sulfate concentrations (pollution) was evident. (Author's abstract)
W90-08918

OCCURRENCE AND FATE OF ORGANIC SOLVENT RESIDUES IN ANOXIC GROUNDWATER AT THE GLOUCESTER LANDFILL, CANADA.
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W90-08947

FACTORS AFFECTING WATER-SUPPLY POTENTIAL OF THE TWIN CITIES METROPOLITAN AREA AQUIFER SYSTEM.
Geological Survey, St. Paul, MN. Water Resources Div.
M. E. Schoenberg.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 38-47, Fall 1989. 2 fig, 1 tab, 49 ref.

Descriptors: *Aquifers, *Glacial aquifers, *Groundwater availability, *Minnesota, *Potential water supply, *Water supply, *Water supply development, Confined aquifers, Selective withdrawal, Water table decline.

The Twin Cities aquifer system in Minnesota contains five aquifers and four confining units that together consist of fourteen geologic units. Unconsolidated sand and gravel aquifers overlie bedrock sandstone and carbonate aquifers. Between 1880 and 1980, groundwater withdrawals have caused long-term water level declines of as much as 90 feet in the Prairie du Chien-Jordan aquifer and 240 feet in the deeper Mount Simon-Hinckley aquifer, the two major sources of groundwater supplies in the area. The estimated maximum continuous withdrawal rate from the aquifer system is about 650 million gallons per day (Mgal/d). This compares with an average daily groundwater usage on an annual basis of about 200 Mgal/d from the late 1970s through 1986, the last year of normal precipitation. Increased costs of withdrawing groundwater, increased risks of decreased groundwater quality, and increased conflicts between simultaneous users of groundwater resources are associated with increased rates of groundwater withdrawal. The principal physical factors affecting water-supply potential are those that control the rate at which water may be withdrawn from the Mississippi River and the Twin Cities aquifer system. (Author's abstract)
W90-08975

RESIDENCE TIMES OF MINNESOTA GROUNDWATERS.
S. C. Alexander, and E. C. Alexander.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 48-52, Fall 1989. 4 fig, 14 ref.

Descriptors: *Carbon radioisotopes, *Groundwater dating, *Groundwater pollution, *Groundwater recharge, *Isotope studies, *Minnesota, *Nitrates, *Tritium, *Water pollution sources, Abandoned wells, Agricultural chemicals, Septic sources, Well water, Wells.

Over the past two decades, tritium and C14 have successfully been used to determine the age of groundwaters around the world. Tritium, C14, and nitrate analyses were performed upon eighty groundwater samples collected from nine of the fourteen principal aquifers in Minnesota. Analytical results indicate a range of residence times from a few days or weeks to tens of thousands of years. High relative concentrations of tritium and C14 indicate the water has probably entered the groundwater system since 1954, and is categorized as recent water. Waters relatively low in tritium and C14 have not been in contact with the atmosphere for a long time and are categorized as vintage water. Wells in aquifers with short residence times are prone to contamination from local sources such as underground tanks, agricultural chemicals, or septic tanks. Wells in aquifers with long residence times are more susceptible to contamination from improperly constructed or abandoned wells. The presence of significant nitrate contamination in groundwater is confined to recent or mixed groundwaters. Isotopic studies can yield information that will be useful in the design of

effective groundwater protection plans, such as whether or not a well is well drawing recent or vintage water. (Tappert-PTT)
W90-08976

NITROGEN MANAGEMENT RELATED TO GROUNDWATER QUALITY IN MINNESOTA.
Minnesota Univ., St. Paul. Dept. of Soil Science.
For primary bibliographic entry see Field 5G.
W90-08977

VIRUSES AND DRUG RESISTANT BACTERIA IN GROUNDWATER OF SOUTHEASTERN MINNESOTA.
For primary bibliographic entry see Field 5B.
W90-08978

HYDROLOGIC MODEL FOR MINNESOTA PEATLANDS.
Minnesota Univ., St. Paul. Dept. of Forest Resources.
For primary bibliographic entry see Field 2H.
W90-08987

THERMAL AND MINERAL SPRINGS AROUND THE SOUTHERN HIGHWAY, REGIONS X-XI, CHILE (FUENTES TERMALES Y MINERALES EN TORNO A LA CARRETERA AUSTRAL, REGIONES X-XI, CHILE).
Servicio Nacional de Geologia y Mineria, Santiago (Chile).
A. Hauser.
Revista Geologica de Chile RGCHDR, Vol. 16, No. 2, p 229-239, 1989. 3 fig, 2 tab, 14 ref, append. English summary.

Descriptors: *Chile, *Fault springs, *Hot springs, *Mineral springs, *Thermal springs, Geologic fractures, Meteoric water, Springs, Water chemistry.

Twenty-five hot springs (24 thermal and 1 mineral water occurrences) were identified and studied in Regions X and XI during the construction of the Carretera Longitudinal Austral (Southern Longitudinal Road) in the past seven years. Five springs have some kind of development as bathing resorts (Llancahue, El Amarillo, Puerto Bonito, Puyuhuapi, and Quitralco). Hydrochemical analyses indicate that nearly all the waters are neutral, and rich in chloride, sulfate, and sodium. They reach the surface at temperatures between 23C and 84C. Water flux is continuous, with slight fluctuations related to rains and/or tidal influences. Most of the springs are closely related to the Liquine-Ofqui and Yanteles-Melimoyu fault zones. These faults seem to control the inflow of meteoric waters; their subsequent heating at depth in a high geothermal gradient environment favors their convective rising, carrying dissolved minerals leached from the granitoids of the North-Patagonian Batholith. (Author's abstract)
W90-08996

SOIL POROSITY IN A PEACH ORCHARD AS INFLUENCED BY WATER TABLE DEPTH.
Consiglio Nazionale delle Ricerche, Pisa (Italy). Ist. per la Chimica del Terreno.
For primary bibliographic entry see Field 2G.
W90-09009

LONG-TERM MOISTURE CONTROL FOR SOILS WITH SHALLOW GROUNDWATER TABLE.
Agricultural Univ. of Warsaw (Poland). Dept. of Land Reclamation.
For primary bibliographic entry see Field 2G.
W90-09010

MODELING WATER TABLE CONTRIBUTION TO CROP EVAPOTRANSPIRATION.
Utah State Univ., Logan. Dept. of Soil Science and Biometeorology.
For primary bibliographic entry see Field 2D.
W90-09018

SEAWATER INTRUSION INTO ESTUARIES AND AQUIFERS.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2L.
W90-09031

HYDROLOGY OF FINE-GRAINED MATERIALS.
W. A. Pettyjohn.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 117-132, 6 fig, 6 ref.

Descriptors: *Groundwater pollution, *Groundwater quality, *Groundwater recharge, *Hydrologic properties, *Path of pollutants, *Water pollution sources, Evapotranspiration, Flow velocity, Hydraulic conductivity, Monitoring wells, Nitrates, Oklahoma, Risk assessment, Shallow aquifers, Soil water, Storms.

In shallow or surficial aquifers the chemical and probably the biological quality can change, within a matter of hours, both vertically and horizontally. This is particularly so in fine-grained systems, systems that might normally be considered as confining units, even though they may be capable of providing a considerable amount of water to a well. Data were collected from a field site in Oklahoma over a period of 18 months from 28 monitoring wells. The site is on private property where the only potential source of groundwater contamination is the application of fertilizers and pesticides. Data indicate that the chemical quality of the shallow groundwater can change throughout the year, and that water quality in fine-grained deposits can range widely both vertically and horizontally due to natural causes. Vertical flow velocities through the unsaturated zone can exceed 5.5 ft/day, even though there is a soil moisture deficiency. Within 48 hours after a rain, the concentration of nitrate can increase fourfold, and within an additional 48 hours can decrease at least fivefold from the previous high, due to macropore flow. Convective storms of high intensity, short duration, and small areal extent appear to have a greater impact on changes in groundwater quality than do typical cyclonic systems. The smallest changes in chemical quality and soil moisture occur in the vicinity of large trees and and appears to be related to evapotranspiration. Due to fractures, materials that would otherwise be considered low hydraulic conductors are not. The assumption that there is a single value for the background concentration of some chemical parameters appears to be false. The hydraulic gradient, flow direction, and groundwater velocity in shallow aquifers can change dramatically from one season to another, and conductivity may be substantially greater vertically than horizontally. Fully penetrating wells reflect concentrations that are higher or lower than other wells that sample a smaller interval. (See also W90-09063) (Fish-PTT)
W90-09068

BIOTRANSFORMATION OF CONTAMINANTS IN GROUND WATER.
E. J. Bouwer.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 133-151, 1 fig, 5 tab, 28 ref. EPA Grant EPA-R-811345010.

Descriptors: *Biotransformation, *Cleanup, *Fate of pollutants, *Groundwater pollution, *Groundwater quality, *Water pollution treatment, *Water quality control, Aliphatic hydrocarbons, Bacteria, Biodegradation, Biofilm reactors, Bioremediation, Field tests, Microenvironment, Oxidation-reduction potential, Shallow aquifers.

Biotransformation can be a significant process affecting the fate of contaminants in the subsurface. Diverse and metabolically active microorganisms have been found in shallow and deep aquifers, and they have been observed to transform some commonly recognized organic contaminants. The importance of the redox environment was studied in biofilm microcosms. Trace concentrations of chlorinated benzenes and several 1-carbon to 3-carbon halogenated aliphatics were biotransformed by acetate-supported biofilms; 3-carbon halogenated aliphatics under aerobic conditions. The type of electron acceptor used by the microorganisms was an important factor affecting transformation pathway and utilization rates. Biotransformation has the potential to treat the contamination in situ, and can result in destruction of the contaminant rather than simple transfer to another environmental medium that occurs with land disposal, air stripping, or activated carbon treatment. Biorestoration schemes that have been proposed include: (1) stimulation of native bacteria by satisfying their needs for energy source, electron acceptor, and other growth factors, so that they can transform contaminants; (2) addition of acclimated microorganisms obtained by enrichment culture or genetic manipulation; and (3) development of a localized zone of biological activity that would intercept the groundwater flow and cleanse the water as it flows by the microorganisms. A great deal of development work on in situ biorestoration is needed before this can become a reliable mitigation process. (See also W90-09063) (Fish-PTT)
W90-09069

GROUND WATER CLEANUPS AND STANDARDS.
J. Quarles.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 189-215, append.

Descriptors: *Cleanup, *Environmental protection, *Groundwater pollution, *Groundwater quality, *Management planning, *Water pollution treatment, *Water quality control, Public health, Regulations, Resource Conservation and Recovery Act, Superfund, Water quality standards.

As a country, the U.S. is lurching into groundwater protection efforts with no clear objectives in mind. Standards are not going to work very well in the groundwater area because of three significant reasons: (1) groundwater sampling is more laborious and costly than is air or surface water sampling; (2) there is no real mixing in groundwater, in dramatic contrast to surface water and air; and (3) there is no uniformity of exposure. Under both the Resource Conservation and Recovery Act (RCRA) and Superfund, standards now exist that determine how clean a site has to be to satisfy the statutory directive. However, current groundwater quality standards are still of limited use; there is a tremendous need to distinguish between prevention and cure, and cleanup and protection. The focus needs to be placed on groundwater as a resource--what it is used for, how much is needed, and the location of its source. Only when these points are addressed can the question be answered concerning human exposure to any contaminants contained in groundwater. Then, a strategy can be developed that will really protect the public. (See also W90-09063) (Fish-PTT)
W90-09070

HOW CLEAN IS CLEAN GROUND WATER REMEDIATED BY IN SITU BIORESTORATION.
For primary bibliographic entry see Field 5G.
W90-09072

RISK CALCULATION AS A STANDARD FOR CLEANUP.
For primary bibliographic entry see Field 6B.
W90-09073

HOW CLEAN IS CLEAN: HOW DO WE DECIDE WHAT TO DO.
For primary bibliographic entry see Field 5G.

W90-09074

NEW APPROACH TO THE DISPOSAL OF SOLID WASTE ON LAND.
For primary bibliographic entry see Field 5E.
W90-09075

BIODEGRADATION OF GROUND WATER POLLUTANTS WHEN OXYGEN IS UNAVAILABLE.
For primary bibliographic entry see Field 5B.
W90-09076

CURRENT AND EMERGING TECHNOLOGIES IN REMEDIATION.
For primary bibliographic entry see Field 5G.
W90-09078

RECENT ADVANCES IN THE IN SITU MANAGEMENT OF UNCONTROLLED WASTE DISPOSAL SITES.
For primary bibliographic entry see Field 5G.
W90-09079

GROUND WATER CLASSIFICATION.
For primary bibliographic entry see Field 5G.
W90-09080

GROUND WATER CLASSIFICATION: GOALS AND BASIS.
For primary bibliographic entry see Field 5G.
W90-09081

GROUND WATER CLASSIFICATION: A STATE PERSPECTIVE.
T. M. Hellman.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 361-366.

Descriptors: *Classification, *Groundwater management, *Groundwater pollution, *Groundwater quality, *Water pollution control, Aquifers, Connecticut, Environmental protection, Geohydrology, State jurisdiction, Water policy, Water quality management.

A report was generated by the National Research Council Committee on Groundwater Quality Protection titled 'Groundwater Quality Protection,' published in 1986, summarizing the committee's review of ten state and three local area groundwater protection programs. Classification systems are used to classify waters for differential groundwater protection strategies. Geographic areas, aquifers, or portions of aquifers are identified and placed in different categories, each of which is afforded a different level of protection. Groundwater classification provides a way of balancing conflicting societal demands for clean groundwater and for the products of a modern, industrialized society. At least ten states and one territory rely on a classification system to manage their groundwater. Connecticut's program integrates groundwater and surface water management into a single, consistent program. A comprehensive classification system such as that used in Connecticut can be an effective tool for optimizing groundwater protection efforts. Comprehensive classification programs depend on adequate geohydrological information to be effective. (See also W90-09063) (Fish-PTT)
W90-09082

GROUND WATER CLASSIFICATION.
V. M. Smith.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 367-376.

Group 2F—Groundwater

Descriptors: *Classification, *Environmental policy, *Groundwater management, *Groundwater pollution, *Groundwater quality, *Institutions, *Water pollution control, *Water resources management, Environmental protection, Geohydrology, Policy making, Public health, Water policy.

The Environmental Policy Institute believes that no matter what the overall groundwater policy is, classification can be used to set priorities for a given point in time or over time, and to selectively apply a limited pool of resources to policy implementation. In doing so, geohydrologic variability can be recognized, as well as uncertainties and possibilities for failure in environmental control. Currently, it may be somewhat difficult to make a judgement with the limited information available in the EPA classification guidelines. One goal of classification is that of eliminating inconsistencies between programs. Another is that of guiding future land uses. Terms such as aquifers, aquitards, permeability, and interconnection, even if firmly defined in one's mind or in the minds of the regulators, are often relative terms in the real world. The point is to act on groundwater classification only with a full consideration of the variables that will affect artificially drawn boundaries, and to consider both the technical and the institutional problems inherent in controlling those variables. There is still the question of whether protection of groundwater to a level which protects human health is necessarily the highest level of protection to be concerned with. The Environmental Policy Institute is not at all certain that the EPA's approach to groundwater classification will buy any significant groundwater protection enhancements. The emphasis that is being developed on the national level may be one to allow for loosening up of the existing base line protections, with little or no valid justification for doing so. (See also W90-09063) (Fish-PTT)
W90-09083

DEVELOPMENT OF A GROUND WATER MANAGEMENT AND AQUIFER PROTECTION PLAN.
For primary bibliographic entry see Field 5G.
W90-09084

RESOURCE PROTECTION VS. SOURCE CONTROL STRATEGIES.
For primary bibliographic entry see Field 6B.
W90-09085

GROUND WATER: A STATE GOVERNMENT PERSPECTIVE.
For primary bibliographic entry see Field 5G.
W90-09086

PUBLIC PARTICIPATION IN GROUND WATER PROTECTION.
For primary bibliographic entry see Field 5G.
W90-09087

INVESTIGATION BY DC RESISTIVITY METHODS OF A GROUND-WATER BARRIER BENEATH THE SAN BERNARDINO VALLEY, SOUTHERN CALIFORNIA.
California Univ., Riverside. Inst. of Geophysics and Planetary Physics.
S. K. Park, D. W. Lambert, and T.-C. Lee.
Ground Water GRWAAP, Vol. 28, No. 3, p 344-349, May/June 1990. 7 fig, 9 ref.

Descriptors: *California, *Geohydrology, *Geologic fractures, *Geophysical exploration, *Geophysics, *Groundwater barriers, *Model studies, *Resistivity, *Resistivity surveys, Aquifers, Hydraulic gradient, Sounding.

DC resistivity methods were used to confirm the existence of the Bryn Mawr fault and to evaluate its efficacy as a barrier to groundwater in the Bunker Hill Basin beneath the San Bernardino Valley, California. Vertical electrical sounding indicated layering and vertical offsets across the fault. Dipole-dipole measurements located the fault and determined its attitude. Modeling indicated

that the fault gouge has decreasing resistivity with depth. The resistivity trend is likely caused by increasing clay content. If the interpretation is correct, the ability of the fault to impede groundwater flow will increase with declining water levels. This theory is supported by greater offset of water levels across the fault when the levels were deeper. DC resistivity methods independently yield models which are consistent with known hydrogeological conditions, and can be used to predict them. (Author's abstract)
W90-09133

AQUIFER PARAMETERS FROM A ONE-DIMENSIONAL STEADY-LEAKY TYPE CURVE.
Florida Univ., Gainesville. Dept. of Civil Engineering.
L. H. Motz.
Ground Water GRWAAP, Vol. 28, No. 3, p 350-356, May/June 1990. 8 fig, 1 tab, 13 ref.

Descriptors: *Aquifer characteristics, *Leakage, *Leaky aquifers, *Mathematical models, *Pumping tests, Confined aquifers, Drawdown, Upper Floridan Aquifer.

A drain function and type curve were defined for the one-dimensional steady-state leaky aquifer case, and match-point procedure was developed for determining the aquifer parameters of transmissivity and leakance. Values for these parameters can be determined by plotting steady-state values of drawdown versus distance and matching the distance-drawdown data to the steady-leaky type curve. The procedure is illustrated by an examples that utilizes field data from a canal pumping test in the Tampa, Florida area. Values of transmissivity = 164,000 sq ft/day and leakance = 0.0049/day were determined for the Upper Floridan aquifer from distance-drawdown and canal flow rate data. These values compare favorably with values of transmissivity and leakance determined from pumping tests and a digital model study in the same area. (Author's abstract)
W90-09134

ESTIMATING THE PRECISION OF GROUND-WATER ELEVATION DATA.
Illinois State Psychiatric Inst., Chicago. Biometric Lab.
R. D. Gibbons.
Ground Water GRWAAP, Vol. 28, No. 3, p 357-360, May/June 1990. 4 tab, 4 ref.

Descriptors: *Algorithms, *Data analysis, *Groundwater level, *Statistical methods, Graphical methods, Monitoring, Spatial distribution, Temporal distribution.

A common problem in groundwater monitoring and hydrogeology in general is determining the precision with which to plot groundwater elevation contours. A variance component decomposition makes it possible to partition the overall variation into unique components due to temporal, spatial, and random variability. The precision of contour plots (i.e., the minimum interval at which contours should be plotted) is a direct function of the size of the random component of variance. In the present example, the major component of variance was due to well variation, approximately one foot; the second largest due to random variation, approximately one-half foot; and the smallest was due to temporal variation, approximately one-fourth foot. Selecting a contour plotting interval of three-fourths of a foot will provide 95% confidence that the random sampling fluctuations will not influence the contour plot. Adjusting the groundwater elevation measurements for systematic seasonal and spatial trends minimizes the random well and time effects, but leaves the residual variance unchanged. However, ignoring serial dependence (i.e., autocorrelation), leads to an underestimate of the residual variance. This downward bias is expected, since correlation must limit variability. In the present example based on 59 historical measurements, this bias in residual standard deviation was approximately 8%. (Author's abstract)
W90-09135

SURVEY OF MICROBIAL POPULATIONS IN BURIED-VALLEY AQUIFER SEDIMENTS FROM NORTHEASTERN KANSAS.
NSI Technology Services Corp., Ada, OK.
J. L. Sinclair, S. J. Randtke, J. E. Denne, L. R. Hathaway, and W. C. Ghiorse.
Ground Water GRWAAP, Vol. 28, No. 3, p 369-377, May/June 1990. 5 fig, 2 tab, 41 ref. Department of Interior Grants 14-08-0001-G-1018-0 and 14-08-0001-G-1226-07. DOE Grant DE-FG02-86ER6047.

Descriptors: *Aquatic bacteria, *Aquifer characteristics, *Groundwater quality, *Microbiological studies, *Microorganisms, *Sediments, Kansas, Population density, Protozoa, Species diversity.

Twenty-two aseptically collected sediment core samples were obtained from below the water table (60 to 280 feet deep) at four pristine sites along a major buried-valley aquifer system in northeastern Kansas. Samples were examined for total numbers of bacteria, viable aerobic bacteria, protozoa, and fungi. Contiguous samples were obtained in some transition zones of sediment texture or color in order to detect possible population shifts over small vertical distances related to changes in sediment characteristics. Total counts of bacteria varied between 1 100 million per gram of dry sediment. Viable bacterial counts varied between 0 and 100 million colony forming units per gram, usually being higher in sandy or gravelly sediments than in silty or clayey sediments. The relationship between sediment texture and microbial population density was confirmed statistically. Total numbers of bacteria correlated highly with variations in sediment sand and clay content. The population densities of viable bacteria and protozoa correlated moderately with these indicators of sediment texture. In some samples, densities of viable bacteria and protozoa correlated moderately with these indicators of sediment texture. In some samples, populations of viable bacteria approached the total count of bacteria and the diversity of bacterial colony types approached populations of viable bacteria approached the total count of bacteria and the diversity of bacterial colony types approached that found in surface soil. Protozoa were found at low population densities in the coarser textured samples. The protozoa were similar to types commonly encountered in surface soil. No actinomycetes, fungi, or algae were detected in any samples. (Author's abstract)
W90-09137

ROLE OF PUMPING TESTS IN SITE CHARACTERIZATION: SOME THEORETICAL CONSIDERATIONS.
Kansas State Geological Survey, Lawrence.
J. J. Butler.
Ground Water GRWAAP, Vol. 28, No. 3, p 394-402, May/June 1990. 8 fig, 1 tab, 29 ref.

Descriptors: *Aquifer characteristics, *Aquifer testing, *Groundwater movement, *Pumping tests, Drawdown, Slug tests, Test wells, Theoretical analysis.

Pumping tests are the primary means of estimating the large-scale storage and transmissive properties of an aquifer for site characterization investigations. Most analyses of pumping-induced drawdown are performed using either the Theis log-log curve-matching procedure or the approximate Cooper-Jacob semilog method. These two procedures provide dissimilar estimates in nonuniform aquifers due to their emphasis on properties in different portions of a unit. The log-log curve-matching approach heavily weights the properties of local material, while the semilog procedure emphasizes the properties of material within the front of the cone of depression. The different emphasis of the two procedures results in log-log parameters being more appropriate for estimating pumping-well drawdown, while semilog parameters are better for estimating well yield. The magnitude of the difference between parameters estimated by the two approaches is a function of the degree of aquifer nonuniformity and the distance between the observation and pumping wells. The further the observation well is from the pumping well, the

smaller the difference between the parameters. The difference between parameters estimated by slug tests and those estimated by pumping tests, on the other hand, will increase with this distance. Due to their emphasis on near-well materials, slug-test parameters may be of use in estimating pumping-well drawdown when employed in a patchy aquifer model. In general, predictions of aquifer behavior can be improved by more careful application of the conventional techniques used in pumping-test analyses. (Author's abstract)
W90-09140

GROUND-WATER CONTAMINATION BY HIGH-DENSITY IMMISCIBLE HYDROCARBON SLUGS IN GRAVITY-DRIVEN GRAVEL AQUIFERS.
Washington State Univ., Pullman. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5B.
W90-09141

STABILIZATION ROLE OF GROUNDWATER WHEN SURFACE WATER SUPPLIES ARE UNCERTAIN: THE IMPLICATIONS FOR GROUNDWATER DEVELOPMENT.
Minnesota Univ., St. Paul. Dept. of Agricultural and Applied Economics.
For primary bibliographic entry see Field 3F.
W90-09155

LUMPED VERSUS DISTRIBUTED MASS MATRICES IN THE FINITE ELEMENT SOLUTION OF SUBSURFACE FLOW.
Reading Univ. (England). Dept. of Mathematics.
W. L. Wood, and A. Calver.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 819-825, May 1990. 3 fig, 2 tab, 13 ref.

Descriptors: *Groundwater movement, *Mathematical models, *Model studies, *Porous media, *Richards equation, *Saturated flow, *Storm seepage, *Unsaturated flow, Finite element method, Flow, Hydraulic potential, Slopes, Soil water.

The method for space discretization by finite elements (lumped or distributed mass matrix) in the Richards' equation for saturated-unsaturated porus media flow was studied. It was strongly recommended that a distributed mass matrix be used. The rates of convergence and model run times were similar between lumped or distributed cases. Although the difference in the hydraulic potential finite element solution using the two methods was small under slowly varying conditions, this difference approached and exceeded observation error under rapidly varying conditions. When discharge was calculated from predicted hydraulic potential, the difference between lumped and distributed discharges from the foot of the slope were hydrologically significant in some cases, especially under rapidly varying conditions. Calculation of discharge from the hydraulic potential also was considerably in excess of field measurement error under rapidly varying conditions. If a good, rather than very good, spatial discretization of the finite element domain was used for purposes of efficiency, use of the distributed mass matrix is particularly important. (Cassar-PTT)
W90-09156

EFFECTS OF CORE-SCALE HETEROGENEITY ON STEADY STATE AND TRANSIENT FLUID FLOW IN POROUS MEDIA: NUMERICAL ANALYSIS.
Alberta Research Council, Edmonton.
S. Bachu, and D. Cuthiell.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 863-874, May 1990. 10 fig, 1 tab, 36 ref.

Descriptors: *Fluid flow, *Groundwater movement, *Model studies, *Porous media, *Simulation analysis, Anisotropy, Aquifers, Heterogeneity, Hydraulic conductivity, Mathematical studies, Numerical analysis, Oil shale, Shales, Stochastic process.

Numerical simulations were used in an inverse approach to study the effects of actual core-scale heterogeneity on the steady state and transient fluid flow in aquifers and hydrocarbon reservoirs. The heterogeneous porous medium consisted of a homogeneous and isotropic shale embedded in a homogeneous and isotropic sand matrix. The data were obtained by digitizing shale clasts from cores in a heavy oil reservoir. The steady state effective hydraulic conductivity generally had values between the geometric and arithmetic averages of the two component values. The dependence of the effective hydraulic conductivity on the heterogeneity fraction and conductivity contrast between the clasts and the matrix was described empirically by a power-average model. The reduction in the effective conductivity showed an asymptotic behavior for conductivity contrasts greater than 2 orders of magnitude. When multiple heterogeneity scales were present, a sequential approach was used, by which heterogeneous media at smaller scales were replaced successively by homogeneous media characterized by corresponding effective hydraulic conductivities. For transient flow, the effective values of hydraulic conductivity and specific storage were time and flow dependent, with asymptotic behavior toward the steady state effective value for hydraulic conductivity and toward the space-average value for specific storage. The error in using steady state effective hydraulic conductivity and space-average specific storage was relatively large for rapidly varying flows but was acceptable for slowly varying flows. Generally, the results of the numerical simulations show that the effective values of hydraulic parameters and dependent on both the intrinsic structure of the heterogeneous porous medium and on the flow process. (Author's abstract)
W90-09161

OPTIMIZATION OF THE PUMPING SCHEDULE IN AQUIFER REMEDIATION UNDER UNCERTAINTY.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 5G.
W90-09162

QUASI-LINEAR THEORY OF NON-FICKIAN AND FICKIAN SUBSURFACE DISPERSION: I. THEORETICAL ANALYSIS WITH APPLICATION TO ISOTROPIC MEDIA.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 5B.
W90-09163

QUASI-LINEAR THEORY OF NON-FICKIAN AND FICKIAN SUBSURFACE DISPERSION: II. APPLICATION TO ANISOTROPIC MEDIA AND THE BORDEN SITE.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 5B.
W90-09164

PARTICLE VELOCITY INTERPOLATION IN BLOCK-CENTERED FINITE DIFFERENCE GROUNDWATER FLOW MODELS.
Geological Survey, Reston, VA. Water Resources Div.
D. J. Goode.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 925-940, May 1990. 17 fig, 2 tab, 22 ref.

Descriptors: *Finite difference methods, *Groundwater movement, *Hydraulic conductivity, *Model studies, *Transmissivity, Aquifers, Flow velocity, Heterogeneity, Mathematical studies, Nonuniform flow.

A new interpolation scheme (designated grad scheme) for particle velocity in groundwater flow models was introduced. It uses potentiometric head gradients and offers improved accuracy for nonuniform flow in heterogeneous aquifers with abrupt changes in transmissivity. The grad scheme was shown to be equivalent to bilinear interpolation in homogeneous media and equivalent to linear interpolation where gradients are uniform. The bilinear interpolation offers improved accuracy over both linear interpolation and the grad scheme if transmissivity is assumed to vary smoothly. The experiments used to compare the grad scheme, linear interpolation, and bilinear interpolation included (1) radial flow in a homogeneous aquifer, (2) flow to a well in a uniform, regional flow field, (3) refractive flow across a low-hydraulic-conductivity layer, (4) nonuniform flow across a low-hydraulic-conductivity layer, and (5) nonuniform flow in a block-heterogeneous aquifer, and (6) nonuniform flow in a smoothly heterogeneous aquifer. (Cassar-PTT)
W90-09166

MAPPING SATURATED AREAS WITH A HELICOPTER-BORNE C BAND SCATTEROMETER.
Centre de Recherches en Physique de l'Environnement, Issy-les-Moulineaux (France).
For primary bibliographic entry see Field 7B.
W90-09168

NONLINEAR RADIAL FLOW IN CONFINED AQUIFERS TOWARD LARGE-DIAMETER WELLS.
Technical Univ. of Istanbul (Turkey). Dept. of Civil Engineering.
Z. Sen.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 1103-1109, May 1990. 9 fig, 1 tab, 15 ref.

Descriptors: *Aquifers, *Groundwater movement, *Wells, Confined aquifers, Drawdown, Nonlinear flow, Penetrating wells, Radial flow.

Nonlinear flow type curve sets were derived on the basis of Forchheimer flow law for drawdown variations in a large-diameter well which fully penetrates a confined aquifer. Relevant initial boundary value problem solutions were achieved by Boltzmann transformation. The validity of the obtained results were checked against Papadopulos and Cooper type curves applicable only in linear radial flows toward large-diameter wells. The initial portions of all type curves, irrespective of the turbulence factor and the storage coefficient were all straight lines, indicating well storage effects. (Author's abstract)
W90-09181

REVIEW OF GEOSTATISTICS IN GEOHYDROLOGY: I. BASIC CONCEPTS.
American Society of Civil Engineers, New York.
A. P. Georgakakos, P. K. Kitanidis, H. A. Loaiciga, R. A. Olea, and S. R. Yates.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 5, p 612-632, May 1990. 4 fig, 3 tab.

Descriptors: *Geohydrology, *Groundwater movement, *Hydraulic engineering, *Kriging, *Reviews, *Statistical methods, Covariance, Mathematical studies, Model studies, Semivariograms.

This review introduces the basic concepts of geostatistics and its proposed linear and nonlinear estimation (kriging) techniques. These techniques view a regionalized variable as one of many possible outcomes of a random function. The main features of linear geostatistics are (1) it uses the spatial-correlation structure of spatial functions; (2) its estimates are calculated by weighting the measurements with coefficients that are determined from the minimization of the mean square error, subject to unbiasedness conditions; and (3) it can process measurements averaged over different volumes and sizes. The spatial variability of the natural phenomenon is characterized by covariance or semivariogram functions, which are the central elements in the estimation techniques. After the semivariogram has been determined, a variety of tasks, including interpolation, may be performed. Kriging is one interpolation method. An example of kriging shows the estimated specific yields at three points, A, B, and C, from a 20 measured specific yields in a 2500 sq mi area. Several different types of kriging exist. Simple kriging assumes that the mean value is constant and known. Ordinary kriging assumes that the mean value is con-

stant, but unknown. Nonstationary kriging or universal kriging can deal with a drift in data where the stationarity of the mean is questionable. Cokriging, useful in the undersampled problem, uses data collected from related variables. Nonlinear methods include log-kriging, disjunctive kriging, indicator kriging, and probability kriging. Techniques used to infer the statistical structure of variables are described. (See also W90-09188) (Cassar-PTT)
W90-09187

REVIEW OF GEOSTATISTICS IN GEOHYDROLOGY: II. APPLICATIONS.
American Society of Civil Engineers, New York.
A. P. Georgakakos, P. K. Kitanidis, H. A.
Loaiciga, R. A. Olea, and S. R. Yates.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 5, p 633-658, May 1990. 1 fig, 140 ref.

Descriptors: *Geohydrology, *Groundwater movement, *Hydraulic engineering, *Kriging, *Literature review, *Statistical methods, Analytical techniques, Covariance, Flow equations, Groundwater management, Mapping, Mathematical studies, Model studies, Monte Carlo method, Sampling, Simulation analysis, Uncertainty.

Applications of geostatistical techniques in groundwater systems are reviewed in five major categories: (1) mapping of groundwater variables, incorporation of relevant information, and space-time mapping; (2) conditional and unconditional simulations of geohydrological fields; (3) cointerpolation of groundwater variables using the flow equations, and numerical and analytical approaches to estimate cross and direct covariances of these variables based on groundwater-flow equations; (4) global and local sampling designs; and (5) geostatistical groundwater management studies. Several groundwater management models and the associated parameter uncertainty are discussed. Maddock suggests a statistical parameter error and ranking analysis for farm irrigation management. Aguado uses sensitivity analysis to examine how hydraulic conductivity, boundary conditions, and numerical discretization schemes can affect the dewatering strategy of a rectangular excavation site. Tung develops a stochastic groundwater management model that explicitly considers the random effects of transmissivity and storage coefficient in a confined, homogeneous, and transient aquifer. Wagner and Gorelick present a stochastic management scheme for groundwater quality management under parameter uncertainty. Massmann and Freeze set up a comprehensive risk-cost-benefit analysis framework for the design of waste management facilities. (See also W90-09187) (Cassar-PTT)
W90-09188

GENERAL PRINCIPLES OF PESTICIDE MOVEMENT TO GROUNDWATER.
Agricultural Research Organization, Bet-Dagan (Israel). Inst. of Soils and Water.
For primary bibliographic entry see Field 5B.
W90-09260

PESTICIDE POLLUTION OF GROUNDWATER IN THE HUMID UNITED STATES.
Iowa Dept. of Natural Resources, Iowa City.
For primary bibliographic entry see Field 5B.
W90-09261

PESTICIDE CONTAMINATION OF GROUNDWATER IN WESTERN EUROPE.
Institute for Pesticide Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 5B.
W90-09262

GEOCHEMISTRY, AGE, AND ORIGIN OF GROUNDWATER IN A MAFIC PLUTON, EAST BULL LAKE, ONTARIO, CANADA.
Ottawa Univ. (Ontario). Dept. of Geology.
D. J. Bottomley, M. Gascoyne, and D. C. Kamineni.

Geochimica et Cosmochimica Acta GCACAK, Vol. 54, No. 4, p 933-1008, April 1990. 10 fig, 3 tab, 53 ref.

Descriptors: *Canada, *Geochemistry, *Groundwater chemistry, *Groundwater dating, *Groundwater movement, *Paleohydrology, *Water chemistry, Calcium, Carbonates, Groundwater recharge, Magnesium, Saline groundwater, Sodium, Sodium chloride.

The geochemistry of groundwater in the East Bull Lake gabbro-anorthosite pluton near Elliot Lake, Ontario, Canada, investigated. Three chemical types of groundwater are present to depths of about 650 m, and are controlled by the nature of the groundwater flow systems and the water/rock interactions in the fractures. Ca/HCO3 water is present in the recharge area of the local flow system and evolves rapidly along the direction of groundwater flow to a high-pH, Na/HCO3 water primarily by cation exchange reactions. Saline Na/Cl water is present below a depth of about 350 m and is believed to be part of a deep regional groundwater flow system. Carbon-14 measurements of the Na/HCO3 water suggest that this water was recharged shortly after the last Pleistocene deglaciation. This is supported by sigma-18O values that are as much as 6 parts per thousand lighter than shallow modern groundwater. Despite the high Mg content of the enclosing rocks, Mg(2+) concentrations in the groundwater of this unit are <1.0 mg/L, and may be controlled by present-day serpentinization or formation of talc. Laumontite is thermodynamically stable in the Na/HCO3 and Na/Cl waters and hence could still be forming under the present low-temperature conditions (<25 C). The stable isotope composition of the Na/Cl water suggests that this water type is not a geochemically evolved product of the overlying water, although present-day albitization of the anorthosite could be responsible for the increased Ca/Na ratio in the Na/Cl water compared to the other water types. The salinity of this water appears to have been derived outside the pluton, possibly as an ancient infiltration into crystalline basement rocks of saline formation waters present in Paleozoic sedimentary rocks, which formerly overlay the pluton, or from nearby Proterozoic formations. This hypothesis is supported by Br/Cl ratios that are similar to sea water and many present-day formation waters, and the isotopic composition of the dissolved sulfate. The He age of the saline water is of the order of 100,000,000 years. Therefore, both the saline water and many of its solutes appear to have ancient origins. (Author's abstract)
W90-09291

MONITORING WELL INTO ABANDONED DEEP-WELL DISPOSAL FORMATIONS AT SARNIA, ONTARIO.
INTERA Technologies Ltd., Ottawa (Ontario).
For primary bibliographic entry see Field 5E.
W90-09308

SUPPLEMENTARY METHOD FOR ASSESSING THE RELIABILITY OF FLUIDS SAMPLED FROM DEEP AQUIFERS.
Hebrew Univ. of Jerusalem (Israel). Seagram Centre for Soil and Water Sciences.
For primary bibliographic entry see Field 7B.
W90-09310

DETECTION OF NATURALLY OCCURRING BTX DURING A HYDROGEOLOGIC INVESTIGATION.
Gartner Lee, Inc., Niagara Falls, NY.
For primary bibliographic entry see Field 5B.
W90-09311

METHOD TO EVALUATE THE VERTICAL DISTRIBUTION OF VOCS IN GROUND WATER IN A SINGLE BOREHOLE.
Lawrence Livermore National Lab., CA. Environmental Restoration Div.
For primary bibliographic entry see Field 5A.
W90-09312

DIFFERENTIATION OF THE ORIGINS OF BTX IN GROUND WATER USING MULTIVARIATE PLOTS.
National Water Research Inst., Burlington (Ontario). Groundwater Contamination Section.
For primary bibliographic entry see Field 5A.
W90-09313

FACTORS AFFECTING EFFICIENT AQUIFER RESTORATION AT IN SITU URANIUM MINE SITES.
Boise State Univ., ID. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 5G.
W90-09314

INFLUENCE OF CASING MATERIALS ON TRACE-LEVEL CHEMICALS IN WELL WATER.
Cold Regions Research and Engineering Lab., Hanover, NH.
For primary bibliographic entry see Field 5B.
W90-09316

INFLUENCE OF BEST MANAGEMENT PRACTICES ON WATER QUALITY IN THE APPOQUINIMINK WATERSHED.
Delaware Agriculture Experiment Station, Newark.
For primary bibliographic entry see Field 5G.
W90-09320

AQUIFER PARAMETERS FROM CONSTANT DRAWDOWN NONSTEADY-LEAKY TYPE CURVES.
Florida Univ., Gainesville. Dept. of Civil Engineering.
L. H. Motz.
Water Resources Bulletin WARBAQ, Vol. 26, No. 2, p 233-239, April 1990. 4 fig, 1 tab, 12 ref.

Descriptors: *Aquifer characteristics, *Aquifers, *Drawdown, *Groundwater movement, *Leaky aquifers, *Type curves, *Unsteady flow, Boundary conditions, Leakage, Mathematical analysis, Storage coefficient, Transmissivity.

A drain function and set of type curves were defined for the mathematical solution that represents one-dimensional flow under nonsteady conditions in a leaky aquifer for the constant drawdown boundary condition. A match point procedure was developed for determining the aquifer parameters transmissivity, storage coefficient, and leakance based on the drain function and type curves. Use of the procedure is illustrated by an example that utilizes simulated aquifer drawdowns and flow rate data. The drain function and type curves developed in this investigation include the effects of leakage for the constant drawdown boundary condition, which is not included in the existing drain function and type curve found in the literature. Thus, a new set of type curves was developed that can be used to analyze drawdowns for one-dimensional flow in a leaky aquifer with constant drawdown at a line sink. Applications would include flow to a canal or river, drainage of agricultural lands, and dewatering associated with strip mining operations. (Author's abstract)
W90-09347

GROUND WATER FLOW AND RUNOFF IN A COASTAL PLAIN STREAM.
South Carolina State Coll., Orangeburg. Dept. of Natural Sciences.
For primary bibliographic entry see Field 2A.
W90-09358

SOLUTE INPUT INTO GROUNDWATER FROM SANDY SOILS UNDER ARABLE LAND AND CONIFEROUS FOREST: DETERMINATION OF AREA-REPRESENTATIVE MEAN VALUES OF CONCENTRATION.
Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.).
For primary bibliographic entry see Field 5B.

W90-09366

SPECIATION OF ALUMINUM IN GEOTHER-
MAL BRINES: COMPARISON OF DIFFERENT
METHODOLOGIES.
CISE S.p.A., Technologie Innovative, Segrate
(MI), Italy.
For primary bibliographic entry see Field 2K.
W90-09391

EFFECTS OF ACID RAIN AND FOREST DIE-
BACK ON GROUNDWATER--CASE STUDIES
IN BAVARIA, GERMANY (FRG).
Bayerisches Landesamt fuer Wasserwirtschaft,
Munich (Germany, F.R.).
For primary bibliographic entry see Field 5C.
W90-09434

OCCURRENCE OF ATRAZINE IN GROUND-
WATER AS A RESULT OF AGRICULTURAL
USE.
Environmental Protection Agency, Washington,
DC. Office of Pesticide Programs.
For primary bibliographic entry see Field 5B.
W90-09444

HERBICIDE MONITORING OF TILE DRAIN-
AGE AND SHALLOW GROUNDWATER IN
NORTHWESTERN OHIO FARM FIELDS--A
CASE STUDY.
Science Applications International Corp., Denver,
CO.
For primary bibliographic entry see Field 5B.
W90-09445

EFFECT OF AGRICULTURAL CHEMICALS
ON GROUNDWATER QUALITY IN THE NEW
JERSEY PLAIN.
New Jersey Dept. of Environmental Protection,
Trenton. Office of Science and Research.
For primary bibliographic entry see Field 5B.
W90-09446

DEVELOPMENT OF A METHOD FOR DEFIN-
ING THE VARIABILITY IN PESTICIDE CON-
TAMINATION OF GROUNDWATER.
Geraghty and Miller, Inc., Tulsa, OK.
For primary bibliographic entry see Field 5B.
W90-09472

SIMPLIFIED PC-BASED PROCESS-ORIENT-
ED MODEL FOR EVALUATING GROUND-
WATER CONTAMINATION POTENTIAL BY
PESTICIDES.
Virginia Polytechnic Inst. and State Univ., Blacks-
burg. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W90-09473

LIABILITY RULES FOR GROUNDWATER
PESTICIDE CONTAMINATION.
Georgia Univ., Athens. Dept. of Agricultural Eco-
nomics.
For primary bibliographic entry see Field 5G.
W90-09477

PROCEEDINGS OF THE FOCUS CONFER-
ENCE ON EASTERN REGIONAL GROUND
WATER ISSUES.
October 17-19, 1989, Kitchener, Ontario, Canada.
National Water Well Association, Dublin, Ohio.
1989. 481p.

Descriptors: *Groundwater budget, *Groundwater
management, *Groundwater movement, *Ground-
water pollution, *Groundwater quality, Agricul-
tural runoff, Aquifer restoration, Aquifers, Geohy-
drology, Water pollution sources.

This bound volume contains the papers from the
sixth annual FOCUS Conference, and focused on
groundwater issues relevant to the eastern North
American geohydrologic community. Sessions
were devoted to the following topics: investigative

techniques in groundwater; groundwater contami-
nation and liability; agricultural impacts on
groundwater; aquifer restoration; eastern ground-
water management; groundwater and fractured
media; and potpourri. Attendees of the meeting
included government officials, geohydrologists,
consulting engineers, geologists, geochemists, and
industry representatives from the United States and
Canada. (See W90-09480 thru W90-09512) (Au-
thor's abstract)
W90-09479

METHODOLOGY FOR LOCATING AND
MEASURING SUBMERGED DISCHARGES:
TARGETING TOOL, HARPOON PIEZOME-
TER AND MORE.
Atomic Energy of Canada Ltd., Chalk River (On-
tario). Chalk River Nuclear Labs.
For primary bibliographic entry see Field 7B.
W90-09480

METHOD OF VERTICAL CONCENTRATION
PROFILING IN AQUIFERS CONTAMINATED
BY DNAPL.
C-E Environmental, Inc., Portland, ME.
For primary bibliographic entry see Field 5B.
W90-09481

COMPARISON OF METHODS FOR ESTIMAT-
ING GROUNDWATER RECHARGE FROM A
LAKE.
Atomic Energy of Canada Ltd., Chalk River (On-
tario). Chalk River Nuclear Labs.
S. J. Welch, D. R. Lee, and R. W. D. Killey.
IN: Proceedings of the FOCUS Conference on
Eastern Regional Ground Water Issues. October
17-19, 1989, Kitchener, Ontario, Canada. National
Water Well Association, Dublin, Ohio. 1989. p 25-
39, 5 fig, 3 tab, 7 ref.

Descriptors: *Data acquisition, *Groundwater re-
charge, *Instrumentation, *Lakes, *Permeability,
*Piezometers, *Seepage, *Surface-groundwater re-
lations, Hydraulic conductivity, Hydraulic head,
Hydrologic budget, Infiltration, Soil moisture
meters.

A 10 hectare lake with no surface outlet forms the
major recharge area for water entering an aquifer
underlying several waste management facilities.
The lake is underlain by sands and by variable
thicknesses of a relatively low permeability unit of
interstratified sands and silts. The annual average
recharge to the sands from the lake is 230,000 cu
m/a, based on the lake's basin area and on local
measurements of precipitation, evaporation and
evapotranspiration. Determination of the spatial
variability of this recharge over the lakebed is
needed for groundwater modeling studies, and two
approaches to collecting these data have been ap-
plied. Seepage meters installed in the lakebed
yielded infiltration rates ranging from 0 to 2.5 cu
m/sq m/acre and an annual total input of 40,000 cu
m/acre. Subsequent laboratory tests with seepage
meters under discharge conditions have shown ap-
proximately 50% variability when the rates are
below about 1.3 cu m/sq m/acre (37 mL/h). The
second method for measuring spatial variations in
infiltration employed stratigraphic and hydraulic
head data from a series of cored boreholes instru-
mented with multilevel piezometers. Vertical hy-
draulic conductivities were measured by permeam-
eter testing of undisturbed and repacked soil cores.
The Darcy calculations yield an annual infiltration
of 350,000 cu m/a, about 50% greater than the
water balance estimate. The Darcy calculations, of
course, provide lower rates of infiltration where
the interstratified sand and silt unit thickens. Seep-
age meter data show a somewhat similar pattern of
recharge, suggesting that they provide useful infor-
mation on relative rates of recharge. (See also
W90-09479) (Author's abstract)
W90-09482

USING VERTICAL ELECTRICAL SOUNDINGS
TO ACCURATELY MAP A BURIED CHANNEL
IN COASTAL PLAIN SEDIMENTS.
Environmental Resources Management, Inc.,
Exton, PA.

For primary bibliographic entry see Field 7B.
W90-09483

USE OF SOIL GAS INVESTIGATIONS TO
DETECT GROUNDWATER AND SOIL CON-
TAMINATION.
Tracer Research Corp., Tucson, AZ.
For primary bibliographic entry see Field 5A.
W90-09484

PRESERVING WATER QUALITY WITHOUT
SEWERS: A CASE STUDY OF ON-SITE
WASTEWATER DISPOSAL HYDROGEO-
LOGY.
Shevenell Gallen and Associates, Inc., Portsmouth,
NH.
For primary bibliographic entry see Field 5G.
W90-09487

HYDROGEOLOGIC CONSIDERATIONS IN
THE DESIGN AND OPERATION OF A PCB
WASTE CONTAINMENT FACILITY IN
LONDON, ONTARIO.
Conestoga-Rovers and Associates, Waterloo (On-
tario).
For primary bibliographic entry see Field 5E.
W90-09488

NITRATE LOADING METHODOLOGIES FOR
SEPTIC SYSTEM PERFORMANCE PREDIC-
TION: STATE OF AN ART.
Gerber (Robert G.), Inc., Freeport, ME.
For primary bibliographic entry see Field 5G.
W90-09492

CONTROL OF IN-SITU SPILL BIODEGRADA-
TION WITH LYSIMETERS.
Drexel Univ., Philadelphia, PA. Civil Enginering
and Environmental Sciences Inst.
For primary bibliographic entry see Field 5G.
W90-09494

BIOTRANSFORMATION OF BTEX UNDER
ANAEROBIC DENITRIFYING CONDITIONS:
EVALUATION OF FIELD OBSERVATIONS.
Waterloo Univ. (Ontario). Inst. for Ground Water
Research.
For primary bibliographic entry see Field 5G.
W90-09495

DESIGNING A GROUNDWATER EXTRAC-
TION SYSTEM FOR A GEOLOGICALLY COM-
PLEX, LOW-PERMEABILITY AQUIFER IN
SOUTHERN NEW HAMPSHIRE.
Camp, Dresser and McKee, Inc., Boston, MA.
For primary bibliographic entry see Field 5G.
W90-09496

ALTERNATIVE TO LONG-TERM SHUT-
DOWN OF A MUNICIPAL WELL IN A SAND-
AND-GRAVEL AQUIFER CONTAMINATED
BY CYANIDE WASTES, SOUTHERN NEW
HAMPSHIRE.
Whitman and Howard, Inc., Wellesley, MA.
For primary bibliographic entry see Field 4B.
W90-09498

DEVELOPMENT AND DEMONSTRATION OF
AN INTEGRATED APPROACH TO AQUIFER
REMEDIATION AT AN ORGANIC CHEMICAL
PLANT.
Canviro Consultants Ltd., Waterloo (Ontario).
For primary bibliographic entry see Field 5G.
W90-09499

CHARACTERIZATION AND REMEDIAL AS-
SESSMENT OF DNAPL PCB OIL IN FRAC-
TURED BEDROCK: A CASE STUDY OF THE
SMITHVILLE, ONTARIO SITE.
Golder Associates, Mississauga (Ontario).
For primary bibliographic entry see Field 5G.
W90-09501

Group 2F—Groundwater

ARE GROUND WATER VULNERABILITY CLASSIFICATION SYSTEMS WORKABLE.
BCI Geonetics, Inc., Winslow, ME.
For primary bibliographic entry see Field 6B.
W90-09503

DETERMINING THE AREA OF CONTRIBUTION TO A WELL FIELD: A CASE STUDY AND METHODOLOGY FOR WELLHEAD PROTECTION.
BCI Geonetics, Inc., Laconia, NH.
For primary bibliographic entry see Field 4B.
W90-09504

ANALYSIS OF RECENT DATA REGARDING GROUNDWATER CONDITIONS OF NASSAU COUNTY, NEW YORK.
GeoTrans, Inc., Harvard, MA.
For primary bibliographic entry see Field 4C.
W90-09505

ORGANIZATION AND OPERATION OF THE SAVANNAH RIVER PLANT'S GROUNDWATER MONITORING PROGRAM.
Du Pont de Nemours (E.I.) and Co., Pompton Lakes, NJ.
For primary bibliographic entry see Field 5A.
W90-09506

BEHAVIOUR OF DENSE, NON-AQUEOUS PHASE LIQUIDS (DNAPLS) IN FRACTURED MEDIA.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
For primary bibliographic entry see Field 5B.
W90-09509

PERMEABILITY OF FRACTURED ROCKS IN A QUARRY PROPOSED TO BE A SANITARY LANDFILL.
Waterloo Geoscience Consultants Ltd. (Ontario).
W. S. Clarke, W. M. Graziani, P. S. Bulla, and A. E. Magditsch.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 435-448, 5 fig, 1 tab, 6 ref.

Descriptors: *Geohydrology, *Geologic fractures, *Groundwater movement, *Path of pollutants, *Permeability, *Water pollution sources, Aquitards, Geologic formations, Quarries, Sanitary landfills.

The Acton quarry is located at the edge of the Niagara Escarpment approximately 33 km west of Toronto. It is proposed that the mined-out portion of the Acton Quarry be developed into a municipal solid waste landfill. Over the last three years, a detailed geohydrological investigation has been conducted at the site. The results of this investigation were used to: determine conditions at the site for the disposal of municipal solid wastes; assess design concepts; assess potential impacts of the site on the area groundwater resources; and identify and recommend a groundwater monitoring program. Six bedrock formations underlie the quarry. They are the: Amabel Formation; Reynales formation; Cabot Head Formation; Manitoulin Formation; Whirlpool Formation; and, Queenston Formation. The Amabel Formation and the underlying Reynales Formation were shown to have a mean hydraulic conductivities of 2 microns/sec and 0.06 microns/sec, respectively. In order to be conservative in calculations of groundwater movement at the proposed landfill, the Amabel and Reynales Formation were often treated as one hydrostratigraphic unit. The mean hydraulic conductivity values for the upper and lower Cabot Head shales, are 0.03 microns/sec and 0.003 microns/sec. Wells installed in a section of the shale showed very low permeabilities. The Manitoulin Formation was tested ten times, with a mean hydraulic conductivity of 0.0005 microns/sec. The Whirlpool Formation has a mean hydraulic conductivity of 3 microns/sec. This may result in the only groundwater sink, at depth, in the bedrock.

The upper Queenston Formation has a mean hydraulic conductivity of 0.0002 microns/sec. This thick sequence of shales is expected to act as an effective aquitard at the base of the buried bedrock valley, north of the site. The hydraulic conductivity values shown measure the permeability of the rock formations in the horizontal direction. Since the Cabot Head shales represent an important component in the design of the proposed landfill, another phase of study will attempt to determine the in situ permeability values in the vertical direction. (See also W90-09479) (Lantz-PTT)
W90-09510

APPLICATION OF TREATMENT TECHNIQUES TO SOIL VAPOR EXTRACTION SYSTEMS FOR REMEDIATION OF SOILS IN THE UNSATURATED ZONE.
Levine-Fricke, Inc., Emeryville, CA.
For primary bibliographic entry see Field 5G.
W90-09511

HYDROCARBON REMOVAL FROM GROUND WATER-DESIGN CONSIDERATIONS AT LEAKING UNDERGROUND STORAGE TANK SITES.
Stover and Bentley, Inc., Stillwater, OK.
For primary bibliographic entry see Field 5G.
W90-09512

2G. Water In Soils

FATE AND TRANSPORT OF PETROLEUM IN THE UNSATURATED SOIL ZONE UNDER BIOTIC AND ABIOTIC CONDITIONS.
Delaware Univ., Newark. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-08677

ENZYMATIC OXIDATION OF SOME SUBSTITUTED PHENOLS AND AROMATIC AMINES, AND THE BEHAVIOR OF SOME PHENOLOXIDASES IN THE PRESENCE OF SOIL RELATED ADSORBENTS.
Bundesgesundheitsamt, Langen (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene.
For primary bibliographic entry see Field 5G.
W90-08680

MOBILITY AND DISTRIBUTION OF SELENIUM AND SALINITY IN GROUNDWATER AND SOIL OF DRAINED AGRICULTURAL FIELDS, WESTERN SAN JOAQUIN VALLEY OF CALIFORNIA.
Geological Survey, Sacramento, CA.
For primary bibliographic entry see Field 5B.
W90-08756

PHYSICAL AND HYDROLOGICAL PROPERTIES OF MINED SPOILS RECLAIMED BY DIFFERENT AMELIORATION METHODS.
Southern Illinois Univ. at Carbondale. Dept. of Plant and Soil Sciences.
G. W. Theseira, and S. K. Chong.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 65-74, 2 fig, 4 tab, 11 ref.

Descriptors: *Headwaters hydrology, *Mine wastes, *Soil water, *Spoil disposal, *Tillage, Hydraulic conductivity, Soil properties, Soil strength, Waste disposal.

A study was conducted to determine the effects of five combinations of spoil replacement methods and mechanical amelioration techniques on the physical characteristics of mined spoil. The treatments applied were: (1) spoil replacement with pan scraper followed by TLG (vibratory deep tillage) tillage, (2) spoil replacement with pan scraper followed by RAKE (use of an RM 4 rake attached to a backhoe) tillage, (3) spoil replacement with pan scraper without physical amelioration, (4) spoil replacement with conveyor belt with topsoil; and

(5) spoil replacement with conveyor belt without topsoil replacement. A non-mined soil was included in the study as a control for purposes of comparison. The study was conducted as a nested design with three replications nested in each treatment and four sampling depths nested in each replication. All measurements were made on undisturbed soil cores sampled two years after the experimental site had been treated and planted with alfalfa (Medicago sativa L.). Soil strength data were obtained on the plots using a constant velocity recording cone penetrometer. Results showed that bulk densities of the non-mined and TLG tilled plots were not significantly different from each other, but were significantly lower than the other treatments. Soil moisture retention data by depth suggested that the tillage implements were effective at increasing macroporosity at different depths of the profile. Soil strength was found to be not significantly different between the non-mined, RAKE tilled and TLG tilled plots. These had significantly lower soil strengths than did the remainder of the treatments. Sorptivity and effective saturated hydraulic conductivity measurements were found to be extremely variable across treatment, depth, and replication. Consequently, no conclusions could be drawn concerning either. (See also W90-08822) (Author's abstract)
W90-08829

SURFACE AND GROUND WATER ASSESSMENTS SUPPORTING INSTREAM FLOW PROTECTION AT THE HASSAYAMPA RIVER PRESERVE, WICKENBURG, ARIZONA.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2J.
W90-08854

TRACING STORMFLOW SOURCES IN SEEPAGE ZONES USING OXYGEN-18.
Pennsylvania State Univ., University Park. School of Forest Resources.
For primary bibliographic entry see Field 2A.
W90-08873

NET PHOTOSYNTHESIS AND STOMATAL CONDUCTANCE OF PEACH SEEDLINGS AND CUTTINGS IN RESPONSE TO CHANGES IN SOIL WATER POTENTIAL.
Georgia Agricultural Experiment Stations, Griffin.
For primary bibliographic entry see Field 2I.
W90-08907

STUDY OF WATER REPELLENCY AND ITS AMELIORATION IN A YELLOW-BROWN SAND. 1. SEVERITY OF WATER REPELLENCY AND THE EFFECTS OF WETTING AND ABRASION.
Massey Univ., Palmerston North (New Zealand). Dept. of Soil Science.
M. G. Wallis, D. J. Horne, and K. W. McAuliffe.
New Zealand Journal of Agricultural Research NEZFA7, Vol. 33, No. 1, p 139-144, 1990. 3 fig, 1 tab, 31 ref.

Descriptors: *Himatangi sand, *Laboratory methods, *Soil absorption capacity, *Soil moisture retention, *Soil water, *Water repellent soils, Gravimetry, Soil analysis, Soil water potential, Temporal variation.

Water repellency of Himatangi sand was assessed by in situ water infiltration measurements and in the laboratory using the molarity of an ethanol droplet (MED) technique. Infiltration rates on water repellant areas were an order of magnitude lower than rates on adjacent, less repellant areas. The surface (30 mm) soil of cores removed from repellant areas was severely repellant (MED >2.2), and soil to a depth of 150 mm was moderately repellant. MED was strongly correlated with soil carbon content (R-squared = 0.79). Attempts were made to overcome repellency by wetting the soil and by abrasion. The water repellency of Himatangi sand increased when the gravimetric soil water content was increased from 0.03 to 0.05, and then declined rapidly with further increases in

soil water content. Air-dry samples were agitated in an end-over-end shaker for a range of 1 to 48 hours. Soil water repellency was significantly (P < 0.01) reduced by agitation for up to eight hours. Water repellency of samples which had been shaken for 2, 4, 8 and 12 hours significantly (p < 0.01) increased after standing until 72 hours had elapsed. (See also W90-08912) (Author's abstract) W90-08911

STUDY OF WATER REPELLENCY AND ITS AMELIORATION IN A YELLOW-BROWN SAND. 2. USE OF SOME WETTING AGENTS AND THEIR INTERACTION WITH SOME ASPECTS OF IRRIGATION.
Massey Univ., Palmerston North (New Zealand). Dept. of Soil Science.
M. G. Wallis, D. J. Horne, and K. W. McAuliffe.
New Zealand Journal of Agricultural Research NEZFA7, Vol. 33, No. 1, p 145-150, 1990. 4 tab, 12 ref, append.

Descriptors: *Himatangi sand, *Irrigation requirements, *Soil absorption capacity, *Soil water, *Water repellent soils, *Wetting, Field tests, Infiltration, Irrigation programs, Plant growth, Soil moisture.

A range of soil wetting agents was evaluated in glasshouse experiments using the Himatangi sand. Comparisons of application rates required to overcome water repellency and enable ryegrass seedling emergence revealed significant differences (P < 0.05) in product performance. The dilution rate for wetting agent application was found to be a significant (P < 0.05) factor for some products. In a field trial, pasture establishment was improved on plots (4.8 by 10 m) which were band-sprayed with wetting agents (Wettasoil 12 L/hectare, Aquagro 8 L/hectare). Application rates were selected from the glasshouse experiments. However, soil water content had a high spatial variability and did not differ significantly (P > 0.05) between plots. A blanket spray (20 L/hectare) of Wettasoil on a cultivated area (45 sq m) of Himatangi sand increased the surface soil water content relative to untreated soil; however, this effect was not maintained over the following months. Glasshouse experiments were conducted to study the relationship between some aspects of irrigation scheduling and the performance of wetting agents. Delays of up to 14 days in initial wetting following wetting agent application produced no significant (P > 0.05) effect on the ability of two wetting agents to increase soil infiltration. Shorter irrigation return intervals consistently improved plant growth in untreated and wetting-agent-treated Himatangi sand. (See also W90-08911) (Author's abstract) W90-08912

EFFECT OF ZERO AND CONVENTIONAL TILLAGE ON BARLEY YIELD AND NITRATE NITROGEN CONTENT, MOISTURE AND TEMPERATURE OF SOIL IN NORTH-CENTRAL ALBERTA.
Alberta Univ., Edmonton. Dept. of Soil Science.
For primary bibliographic entry see Field 2I. W90-08914

RESIDUAL SOIL MOISTURE AND WHEAT YIELD IN RELATION TO MULCHING AND TILLAGE DURING PRECEDING RAINFED CROP.
Regional Research Station, Sirmur (India).
For primary bibliographic entry see Field 2I. W90-08917

EVALUATING 'DRAINAGE' IN CONTAINER AND OTHER SHALLOW-DRAINED HORTICULTURAL SOIL.
Illinois Univ. at Urbana-Champaign. Dept. of Horticulture.
L. A. Spomer.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 21, No. 3/4, p 221-235, 1990. 7 fig, 22 ref.

Descriptors: *Drainage, *Landscaping, *Pore size, *Soil physical properties, *Soil porosity, Interstitial water, Regression analysis, Soil water, Horticulture.

Shallow-drained horticultural soils utilized in containers, sporting areas, and landscape sites tend to retain excess water and be poorly aerated following irrigation or precipitation. This occurs even when soil hydraulic conductivity is very high. Such poor drainage is widely misconstrued as a consequence of impedance to water flux when it is usually a capillary retention effect. The adequacy of drainage in shallow soils and subsequent corrective measures for poor drainage are often inferred by application of inappropriate criteria. Poor drainage is usually precipitated by unsuitable pore size distribution. Total porosity of a soil contained in a segmented, metal or plastic cylinder, is determined from the volume of water required to saturate it. A plot of water content as a function of soil height (cm) yields the soil moisture characteristic for that soil. (Brunone-PTT)
W90-08937

IMPROVED LEWIS-MILNE EQUATION FOR THE ADVANCE PHASE OF BORDER IRRIGATION.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W90-08949

ESTIMATION OF FIELD SCALE LEACHING RATES FROM CHLORIDE MASS BALANCE AND ELECTROMAGNETIC INDUCTION MEASUREMENTS.
New South Wales Dept. of Agriculture, Deniliquin (Australia).
For primary bibliographic entry see Field 2K.
W90-08950

EFFECTIVE IRRIGATION UNIFORMITY AS RELATED TO ROOT ZONE DEPTH.
Hebrew Univ. of Jerusalem (Israel). Seagram Centre for Soil and Water Sciences.
For primary bibliographic entry see Field 3F.
W90-08951

VARIABILITY OF SOIL WATER TENSION IN A TRICKLE IRRIGATED CHILE PEPPER FIELD.
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
For primary bibliographic entry see Field 3F.
W90-08952

SIMULATED WATER AND SOLUTE DISTRIBUTION FROM A CROSSED TRIPLE LINE-SOURCE.
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
For primary bibliographic entry see Field 3F.
W90-08953

VARIANCE OF WATER ADVANCE IN WIDE-SPACED FURROW IRRIGATION.
Oklahoma State Univ., Stillwater. Dept. of Agronomy.
For primary bibliographic entry see Field 3F.
W90-09004

YIELD VARIABILITY AND WATER USE IN WIDE-SPACED FURROW IRRIGATION.
Oklahoma State Univ., Stillwater. Dept. of Agronomy.
For primary bibliographic entry see Field 3F.
W90-09005

SOIL POROSITY IN A PEACH ORCHARD AS INFLUENCED BY WATER TABLE DEPTH.
Consiglio Nazionale delle Ricerche, Pisa (Italy). Ist. per la Chimica del Terreno.
M. Pagliai, B. Pezzarossa, G. Zerbi, A. Alvino, and R. Pini.
Agricultural Water Management AWMADF, Vol. 16, No. 1/2, p 63-73, August 1989. 7 fig, 13 ref.

CNR, Italy, Special Grant I.P.R.A., subproject 1.

Descriptors: *Porosity, *Soil structure, *Soil water, *Water table, Morphology, Peaches, Plant pathology, Pores, Seasonal variation.

Modifications induced in soil porosity, pore shape, and pore size distribution caused by different levels of shallow water table were investigated in a peach orchard field experiment. Pores larger than 30 micrometer were measured on soil thin sections using the electro-optical image analysis (Quantimet 720) technique. The porosity inside the small aggregates was measured by the mercury intrusion method. Total porosity was significantly higher when the level of the water table was lower and showed a cycling pattern, being higher at the end of the dry summer season and lower at the end of the wet winter. Elongated pores constituted the highest proportion of porosity and showed the largest differences between water table levels. Changes in pore shape and size distribution also were observed. The proportion of large elongated pores (50 to 500 micrometer) was higher where the level of the water table was deeper. Consequently, the shallow water table seemed to degrade the soil structure, reducing the porosity to a level inadequate for plant development. (Author's abstract)
W90-09009

LONG-TERM MOISTURE CONTROL FOR SOILS WITH SHALLOW GROUNDWATER TABLE.
Agricultural Univ. of Warsaw (Poland). Dept. of Land Reclamation.
T. Brandyk, and R. Romanowicz.
Agricultural Water Management AWMADF, Vol. 16, No. 1/2, p 75-85, August 1989. 4 fig, 1 tab, 28 ref.

Descriptors: *Aeration zone, *Soil water, *Soil-water-plant relationships, Darcys law, Ditches, Mathematical studies, Root zone, Theory, Water table.

The application of the steady-state soil moisture flow theory and control theory for the long-term water management of soils is presented. The admissible ranges of both groundwater levels and open-ditch water levels are determined based on Darcy's law for moisture flow in the unsaturated zone. It is shown that, when describing the unsaturated hydraulic conductivity function by an exponential relation, the linearized form of the flow equation may be applied. Comparison of the results of the theoretical calculations with field experiments showed that when the depths of the groundwater level and the water level in the ditches remain within the determined admissible ranges, the soil moisture content of the root zone does not exceed presented limits for periods of up to 10 days. (Author's abstract)
W90-09010

MODELLING THE EFFECTS OF TIED-RIDGING ON WATER CONSERVATION AND CROP YIELDS.
Texas Agricultural Experiment Station, Temple. Blackland Research Center.
For primary bibliographic entry see Field 3F.
W90-09011

NUMERICAL KINEMATIC WAVE MODEL FOR BORDER IRRIGATION.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W90-09017

LUMPED VERSUS DISTRIBUTED MASS MATRICES IN THE FINITE ELEMENT SOLUTION OF SUBSURFACE FLOW.
Reading Univ. (England). Dept. of Mathematics.
For primary bibliographic entry see Field 2F.
W90-09156

Group 2G—Water In Soils

MAPPING SATURATED AREAS WITH A HEL-ICOPTER-BORNE C BAND SCATTERO-METER.
Centre de Recherches en Physique de l'Environnement, Issy-les-Moulineaux (France).
For primary bibliographic entry see Field 7B.
W90-09168

R-5 REVISITED: I. SPATIAL VARIABILITY OF INFILTRATION ON A SMALL RANGELAND CATCHMENT.
California Univ., Berkeley. Dept. of Soil Science.
K. Loague, and G. A. Gander.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 957-971, May 1990. 11 fig, 13 tab, 23 ref.

Descriptors: *Infiltration, *Soil water, *Watersheds, Catchment areas, Pastures, R-5 catchment site, Rainfall, Rainfall-runoff relationships, Spatial variation, Statistical methods, Vegetation.

A large set of data (247 measurements) was collected from steady state infiltration experiments at the R-5 experimental site, Chickasha, Oklahoma, a 0.1 sq km native grassland pasture in a subhumid region. Using geostatistical methods, the spatial variability of infiltration was characterized. The range of spatial persistence for infiltration was very small (<20 m), typical of those found for similar environments. Steady state infiltration rates were linked to vegetation type and were found to vary with time. The uncertainty associated with the infiltration measurements was reduced by changing the grid spacing from 50 to 25 m. Yet, this was not sufficient to map infiltration variability. (See also W90-09170) (Cassar-PTT)
W90-09169

R-5 REVISITED: II. REEVALUATION OF A QUASI-PHYSICALLY BASED RAINFALL-RUNOFF MODEL WITH SUPPLEMENTAL INFORMATION.
California Univ., Berkeley. Dept. of Soil Science.
For primary bibliographic entry see Field 2A.
W90-09170

NATURE OF THE DISPERSIVE FLUX IN SATURATED HETEROGENEOUS POROUS MEDIA.
Geological Survey, Denver, CO. Water Resources Div.
R. L. Naff.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 1013-1026, May 1990. 6 fig, 30 ref, 4 append.

Descriptors: *Groundwater movement, *Path of pollutants, *Porous media, *Solute transport, Aquifers, Dispersion, Heterogeneity, Hydraulic conductivity, Mathematical studies, Model studies, Saturated flow, Tracers.

A method was developed for evaluating the mean transport of a tracer in saturated heterogeneous porous media when the hydraulic conductivity can be represented by a stochastic process; no assumption concerning stationarity of the concentration field was made. The analysis resulted in a transform-space solution for the dispersive flux associated with the mean concentration in a mean uniform flow field when the tracer was conservative. For a pulse input of tracer, general forms for the first four moments in the longitudinal direction are presented. A general form for the global dispersive flux, associated with mean transport, is presented for the case where local dispersion relative to the length scale of heterogeneity, is negligible. The global dispersive flux takes the form of a convolution, over time, of the concentration gradient weighted by the correlation function of the velocity field. In large time, this integral asymptotically approaches a classical Fickian form. The convolution formulation of the global flux manifested itself in early time in the form of non-Gaussian behavior of the mean tracer concentration. Beyond a travel distance equivalent to about 20 length scales of the hydraulic conductivity process, Gaussian behavior of the mean tracer cloud dominated. (Author's abstract)
W90-09173

FRACTAL PROCESSES IN SOIL WATER RETENTION.
Nevada Univ. System, Reno. Desert Research Inst.
S. W. Tyler, and S. W. Wheatcraft.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 1047-1054, May 1990. 5 fig, 23 ref. U.S. Department of Energy Grant DE-FG08-85-NV10461.

Descriptors: *Fractal geometry, *Model studies, *Porous media, *Soil moisture retention, *Soil water, Hydraulic conductivity, Mathematical studies, Pore size, Porosity, Sierpinski carpet, Soil porosity, Soil texture.

A physical conceptual model for soil texture and pore structure based on the concept of fractal geometry was proposed. The paradigm used for the soil pore size distribution was the Sierpinski carpet, which is a fractal that contains self similar holes (pores) over a wide range of scales. The water retention properties of regular and random Sierpinski carpets were evaluated and related directly to the Brooks and Corey (or Campbell) empirical water retention model. Fractal dimensions of typical soils ranged from 1.71 to 1.95, with the highest dimension associated with the finest textured soils. The fractal dimension was shown to strongly control the water retention properties of the Sierpinski carpet 'soil.' Higher fractal dimensions mimicked clay-type soils with very slow dewatering characteristics; and relatively low fractal dimensions, a sandy soil with relatively rapid dewatering characteristics. The proposed model removes the empirical fitting parameters from the soil water retention models and provides parameters with are intrinsic to the nature of the fractal porous structure. The relative permeability functions of Burdine and Mualem were shown to be fractal directly from fractal water retention results. (Cassar-PTT)
W90-09175

DIFFUSION COEFFICIENTS IN GRAVEL UNDER UNSATURATED CONDITIONS.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5G.
W90-09176

EFFECTS OF AMELIORATING EXPOSED SUBSOIL PRIOR TO SOWING ON THE WATER RELATIONS AND PRODUCTIVITY OF PASTURE DURING AN IRRIGATION CYCLE.
Kyabram Research Inst. (Australia). Dept. of Agriculture and Rural Affairs.
For primary bibliographic entry see Field 3F.
W90-09203

SOIL N MINERALIZATION AND NITRIFICATION IN RELATION TO NITROGEN SOLUTION CHEMISTRY IN A SMALL FORESTED WATERSHED.
York Univ., North York (Ontario). Dept. of Geography.
A. R. Hill, and M. Shackleton.
Biogeochemistry BIOGEP, Vol. 8, No. 2, p 167-184, September 1989. 5 fig, 3 tab, 30 ref.

Descriptors: *Forest watersheds, *Mineralization, *Nitrates, *Nitrification, *Nitrogen cycle, *Small watersheds, *Soil chemistry, *Soil water, Groundwater chemistry, Hemlock trees, Maple trees, Ontario, Pine trees, Riparian vegetation, Soil-water-plant relationships, Streams, Toronto.

Spatial variations in soil processes regulating mineral N losses to streams were studied in a small watershed near Toronto, Ontario. Annual net N mineralization in the 0-8 cm soil was measured in adjacent upland and riparian forest stands using in situ soil incubations from April 1985 to 1987. Mean annual rates of soil N mineralization and nitrification were higher in a maple soil (93.8 and 87.0 kg/ha) than in a pine soil (23.3 and 8.2 kg/ha). Very low mean rates of mineralization (3.3 kg/ha) and nitrification (3.4 kg/ha) were found in a riparian hemlock stand. Average NO(3) nitrogen concentrations in soil solutions were 0.3 to 1.0 mg/L in the maple stand and <0.06 mg/L in the pine stand.

Concentrations of NO(3) nitrogen in shallow ground water and stream water were 3 to 4 times greater in a maple subwatershed than in a pine subwatershed. Rapid N uptake by vegetation was an important mechanism reducing solution losses of NO(3) nitrogen in the maple stand. Low rates of nitrification were mainly responsible for negligible NO(3) nitrogen solution losses in the pine stand. (Author's abstract)
W90-09268

ENHANCED DEGRADATION OF CARBA-MOTHIOATE HERBICIDES IN HISTORY SOILS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Plant Pathology, Physiology and Weed Science.
For primary bibliographic entry see Field 5B.
W90-09451

DEGRADATION OF TERBUFOS IN SOILS DURING DROUGHT CONDITIONS.
Clemson Univ., SC. Inst. of Wildlife and Environmental Toxicology.
For primary bibliographic entry see Field 5B.
W90-09452

MOVEMENT OF TRIAZINE HERBICIDES IN CONVENTIONAL AND CONSERVATIVE TILLAGE SYSTEMS.
Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W90-09467

INFLUENCE OF IRRIGATION AND RAIN-FALL ON THE MOVEMENT OF INSECTI-CIDES THROUGH A SANDY LOAM SOIL.
North Dakota Agricultural Experiment Station, Fargo. Dept. of Soil Science.
For primary bibliographic entry see Field 5B.
W90-09471

MODELING AND MEASUREMENT OF TE-BUTHIURON (SPIKE) MOBILITY IN INTER-MOUNTAIN SOILS.
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5B.
W90-09474

PREFERENTIAL FLOW THROUGH MACRO-PORES: TILLAGE IMPLICATIONS.
Illinois Univ. at Urbana-Champaign. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W90-09475

2H. Lakes

CONTAMINANTS IN FOODS OF AQUATIC BIRDS AT KESTERSON RESERVOIR, CALI-FORNIA, 1985.
Patuxent Wildlife Research Center, Laurel, MD.
For primary bibliographic entry see Field 5B.
W90-08644

SELENIUM ACCUMULATION BY RACCOONS EXPOSED TO IRRIGATION DRAINWATER AT KESTERSON NATIONAL WILDLIFE REFUGE, CALIFORNIA, 1986.
Patuxent Wildlife Research Center, Laurel, MD.
For primary bibliographic entry see Field 5B.
W90-08645

EFFECTS OF ELEVATED FOODBORNE SELE-NIUM ON GROWTH AND REPRODUCTION OF THE FATHEAD MINNOW (PIMEPHALES PROMELAS).
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 5C.
W90-08646

EFFECTS OF ATRAZINE ON MICROCOSMS DEVELOPED FROM FOUR NATURAL PLANKTON COMMUNITIES.
Environmental Research Lab.-Duluth, MN.
For primary bibliographic entry see Field 5C.
W90-08652

MOVEMENT OF DISSOLVED RADIONUCLIDES FROM SUBMERGED URANIUM MINE TAILINGS INTO THE SURFACE WATER OF LANGLEY BAY, SASKATCHEWAN, CANADA.
Environmental Protection Service, Regina (Saskatchewan).
For primary bibliographic entry see Field 5B.
W90-08653

EFFECT OF SEDIMENT CONTACT AND UPTAKE MECHANISMS ON ACCUMULATION OF THREE CHLORINATED HYDROCARBONS IN THE MIDGE, CHIRONOMUS RIPARIUS.
Ohio State Univ., Columbus. Environmental Biology Program.
For primary bibliographic entry see Field 5B.
W90-08662

TRIHALOMETHANES IN THE WATER SUPPLIES OF SARDINIA, ITALY.
Cagliari Univ. (Italy). Inst. of Hygiene.
For primary bibliographic entry see Field 5B.
W90-08664

ORGANIC MICROPOLLUTANTS IN LAKES: A SEDIMENTOLOGICAL APPROACH.
Istituto di Ricerca sulle Acque, Brugherio (Italy).
For primary bibliographic entry see Field 5B.
W90-08668

ELECTRON MICROSCOPE AUTORADIOGRAPHIC EXAMINATION OF UPTAKE BEHAVIOR OF LIPOPHILIC CHEMICALS INTO FISH GILL.
Sumitomo Chemical Co. Ltd., Takarazuka (Japan). Biochemistry and Toxicology Lab.
For primary bibliographic entry see Field 5B.
W90-08670

ECOLOGICAL EFFECTS OF ATRAZINE ON TWO OUTDOOR ARTIFICIAL FRESHWATER ECOSYSTEMS.
Technische Univ. Muenchen (Germany, F.R.). Inst. fuer Botanik, Lehrgebiet Systematik und Oekophysiologie.
For primary bibliographic entry see Field 5C.
W90-08693

COMPARISON OF BIOTIC INDEX VALUES FOR INVERTEBRATE COLLECTIONS FROM NATURAL AND ARTIFICIAL SUBSTRATES.
South Dakota State Univ., Brookings. Dept. of Wildlife and Fisheries.
For primary bibliographic entry see Field 5A.
W90-08697

POPULATION DYNAMICS AND FEEDING OF MAYFLY LARVAE IN SOME ACID AND ALKALINE NEW ZEALAND STREAMS.
Canterbury Univ., Christchurch (New Zealand). Dept. of Zoology.
K. J. Collier, and M. J. Winterbourn.
Freshwater Biology FWBLAB, Vol. 23, No. 2, p 181-189, April 1990. 4 fig, 4 tab, 26 ref.

Descriptors: *Acid rain effects, *Acid streams, *Aquatic insects, *Mayflies, *New Zealand, *Stream ecology, Alkaline water, Feeding behavior, Hydrogen ion concentration, Population dynamics, Productivity.

Population dynamics (density, biomass, annual production), gut contents and feeding rates of mayflies (Deleatidium species; Leptophlebiidae) were compared in two naturally acid (mean pH 4.8), brownwater streams and two alkaline (mean pH 7.5),

clearwater streams in South Westland, New Zealand. Mean densities of larvae (range 234-2318/sq m) were higher in alkaline streams on most of the six bimonthly sampling dates. Mean biomass (range 0.020-0.376 g larval dry weight (LDW)/sq m) was always highest at the stable, spring-fed, alkaline site and was lower at the acid sites and another alkaline site where the population was always dominated by small larvae. Annual production was high at the more stable, alkaline site (10.35 gLDW/sq m) but much lower at the other sites (2.49-3.77g/sq m). Gut contents of larvae were dominated by fine (45-75 microm widest diameter) particulate matter (69-99%), diatoms (up to 21%) and, at one site, filamentous algae (8-13%). Grazing rates of mayflies on epilithon were significantly higher on stones taken from acid than alkaline streams and material grazed from acid streams had a higher proportion of inorganic material (87-93% and 61-83% inorganics, respectively). Higher grazing rates may reflect lower quality of epilithic food in acid, brownwater streams, a factor that could contribute to the lower productivity of Deleatidium populations at these sites. (Author's abstract)
W90-08698

CHANGE TO A DIATOM ASSEMBLAGE IN A EUTROPHIC LAKE FOLLOWING POINT SOURCE NUTRIENT RE-DIRECTION: A PALAEOLIMNOLOGICAL APPROACH.
University Coll., London (England). Palaeoecology Research Unit.
For primary bibliographic entry see Field 5G.
W90-08699

DIATOMS AS INDICATORS OF WATER QUALITY IN SOME ENGLISH URBAN LAKES.
Oxford Univ. (England). Geography School.
For primary bibliographic entry see Field 5A.
W90-08700

SEASONAL RESPONSE OF DIATOM COMMUNITIES TO VARIABLE WATER QUALITY IN SOME ENGLISH URBAN LAKES.
Oxford Univ. (England). Geography School.
For primary bibliographic entry see Field 5A.
W90-08701

EXPERIMENTAL EVIDENCE QUANTIFYING THE ROLE OF BENTHIC INVERTEBRATES IN ORGANIC MATTER DYNAMICS OF HEADWATER STREAMS.
Georgia Univ., Athens. Dept. of Entomology.
T. F. Cuffney, J. B. Wallace, and G. J. Lugthart.
Freshwater Biology FWBLAB, Vol. 23, No. 2, p 281-299, April 1990. 9 fig, 12 tab, 58 ref. NSF grants BSR83-16082 and BSR87-18005.

Descriptors: *Benthic fauna, *Invertebrates, *Mountain streams, *Organic matter, Aquatic bacteria, Decomposition, Detritus, Insecticides, Invertebrate drift, Litter, Methoxychlor, Species composition.

The insecticide methoxychlor was applied seasonally to one of three small headwater streams in the southern Appalachian Mountains in North Carolina. The initial application caused massive invertebrate drift (>1,000,000 organisms/wk) and resulted in a community with few shredders and reduced abundances of most insect taxa. Bacteria densities and microbial respiration rates were not affected by treatment. Disruption of the invertebrate community resulted in significant reductions in leaf litter processing rates (50-74% reduction depending on leaf species) and in the amount of leaf litter processed annually (reduction of 25-28%). Reductions in leaf litter processing rates resulted in significant reductions in fine particulate organic matter (FPOM) export. Declines in both concentration and total export were detectable within 1 week of treatment. Annual FPOM export was reduced to 33% of pretreatment levels. Alteration to the invertebrate community had a much greater effect on FPOM export than a severe (50-200 year) drought. Course particulate organic matter export was not significantly influenced by treatment but was influenced by hydrologic differences among years. (Author's abstract)

W90-08702

ENZYMIC AND CHEMICAL ANALYSIS OF PARTICULATE ORGANIC MATTER FROM A BOREAL RIVER.
Clarkson Univ., Potsdam, NY. Dept. of Biology.
R. L. Sinsabaugh, and A. E. Linkins.
Freshwater Biology FWBLAB, Vol. 23, No. 2, p 301-309, April 1990. 5 fig, 4 tab, 22 ref.

Descriptors: *Boreal streams, *Enzymes, *Microbial degradation, *Organic matter, Detritus, Fiber, Limnology, Nitrogen, Particle size, Phenols, Phosphorus, Succession, Water chemistry.

Benthic particulate organic matter (POM) was collected from a shallow pool of a fourth order boreal stream and sorted into seven size fractions ranging from 63 to >4000 microm. Each size fraction was analyzed for fiber, total phosphorus, and total Kjeldahl nitrogen. Microbial activity was measured by oxygen consumption and characterized by assaying for eleven classes of exoenzymes including cellulase, phenol oxidase, peroxidase, phosphatase and sulfatase. Indices of detritus quality such as C/N, C/P, percent lignin, and microbial respiration showed improvement with decreasing particle size. Three covarying exoenzyme groups were identified: a carbohydrase-phosphatase group that included eight enzymes, a phenol oxidase-peroxidase group, and sulfatase. The activity of the carbohydrase-phosphatase group was significantly correlated with microbial respiration and the carbohydrate content of the POM. Phenol oxidase-peroxidase activity was correlated with lignin content for POM greater than 250 microm, but activity increased markedly in the two smallest size fractions even though the lignin content of the POM continued to decline. Sulfatase activity was inversely related to particle size over the entire range. The changes in microbial activity with particle size were attributed to the increasing surface area to volume ratio of smaller particles and to an ecological succession in the microbial community. (Author's abstract)
W90-08703

INFLUENCES OF SEASONAL FLOODING ON MACROINVERTEBRATE ABUNDANCE IN WETLAND HABITATS.
Minnesota Univ., St. Paul. Dept. of Fisheries and Wildlife.
H. A. Neckles, H. R. Murkin, and J. A. Cooper.
Freshwater Biology FWBLAB, Vol. 23, No. 2, p 311-322, April 1990. 3 fig, 3 tab, 32 ref.

Descriptors: *Ecological effects, *Flooding, *Limnology, *Macroinvertebrates, *Marshes, *Population density, *Wetlands, Aquatic insects, Life history studies, Manitoba, Seasonal variation, Vegetation.

The effects of seasonal flooding on macroinvertebrate abundance was studied by manipulating water regime and detrital level within three contiguous experimental marshes in Manitoba, Canada, over a two year period. One area was seasonally flooded (standing water present through midsummer) with emergent vegetation left undisturbed, one was semipermanently flooded (standing water present through the ice-free season) with the vegetation left undisturbed, and one was seasonally flooded with the vegetation harvested at the end of the first summer. Abundances of frequent macroinvertebrate taxa were compared between the seasonally flooded-undisturbed treatment area and each of the other areas. Densities of total invertebrates and of the dominant taxa (Cladocera, Ostracoda, and Culicidae) were reduced dramatically by a year of semipermanent flooding, despite high levels of particulate organic food resources and low populations of predators. Densities were not reduced by lowering the availability of detritus under seasonally flooded conditions. Taxa unaffected by water regime included Dytiscidae, Corixidae, Chironomidae, Ceratopogonidae and Ephydridae. Semipermanent flooding may have eliminated environmental cues necessary for oviposition, embryonic development and hatch among dominant taxa. High invertebrate densities in tem-

porary waters may be more dependent upon life history traits of resident fauna than upon habitat features such as food availability or predation pressure. (Author's abstract)
W90-08704

PHOSPHORUS TRANSFORMATIONS IN THE EPILIMNION OF HUMIC LAKES: BIOLOGICAL UPTAKE OF PHOSPHATE.

Lancaster Univ. (England). Div. of Biological Sciences.
R. I. Jones.
Freshwater Biology FWBLAB, Vol. 23, No. 2, p 323-337, April 1990. 9 fig, 1 tab, 53 ref.

Descriptors: *Algae, *Cycling nutrients, *Dystrophic lakes, *Humic substances, *Limiting nutrients, *Limnology, *Phosphates, Bacteria, Finland, Lake turnover, Microbial degradation.

The hypothesis that dissolved humic material (DHM) stimulates bacterial involvement in phosphorus transformations and may thus lead to decreased accessibility of phosphorus to algae was investigated by studying three small forest lakes in southern Finland representing a wide range of DHM concentrations. Bacterial biomass did not differ significantly between the lakes, but algal biomass was significantly lower at higher DHM concentrations. Consequently the ratio of algal biomass to bacterial biomass was significantly lower in the most humic lake. Uptake of phosphorus from added 33PO4 was partitioned between algal and bacterial size fractions by differential filtration. No significant variation between lakes was found in the proportion of particulate 33P recovered from the algal fraction. Turnover times for phosphate were significantly longer in the most humic lake and also showed lower variability. In general turnover times were long in comparison with values reported from many other lakes. Only briefly in mid summer did turnover times in two lakes shorten to values which would indicate that demand for phosphate was outstripping supply. Short-term storage of samples from the most humic lake stimulated biological incorporation of 33P, but additions of nitrogen and iron had little effect on phosphate uptake. In these small forest lakes it is probable that no single nutrient consistently limits plankton development. Since no evidence was found that DHM shifts the balance of plankton phosphate uptake away from algae towards bacteria, the influence of DHM on phosphorus transformations may be through chemical regulation of free phosphate availability. (Author's abstract)
W90-08705

STRUCTURAL, PHYSICAL AND CHEMICAL CHARACTERISTICS OF MICROCYSTIS AERUGINOSA HYPERSCUMS FROM A HYPERTROPHIC LAKE.

Kinneret Limnological Lab., Tiberias (Israel).
T. Zohary, and A. M. Pais Madeira.
Freshwater Biology FWBLAB, Vol. 23, No. 2, p 339-352, April 1990. 6 fig, 6 tab, 34 ref.

Descriptors: *Cyanophyta, *Decomposing organic matter, *Eutrophic lakes, *Hyperscums, *Hypertrophic lakes, *Limnology, *Scum, *South Africa, Anaerobic conditions, Hartbeespoort Dam, Light penetration, Methanogenesis, Nutrients, Water chemistry, Water movement.

The structural, physical and chemical characteristics of cyanobacterial hyperscums (floating scums of densely packed cyanobacteria, measuring decimeters in thickness, that are covered by a dry crust of photo-oxidized cells) from hypertrophic Hartbeespoort Dam, South Africa were examined. The hyperscum community was a cyanobacterial-bacterial association, in which the cyanobacterium Microcystis aeruginosa comprised 98% of the biovolume, with cell concentrations exceeding 1 billion/ml. The crust attenuated all the incident light and reduced free gas exchange. Beneath it continuously dark anaerobic, highly reduced conditions prevailed. As the hyperscum aged over 3 months in 1984, at 10 cm depth the pH gradually declined from 6.6 to 5.9, interstitial water ammonia-N concentrations increased from 0.45 to 119 mg/L, solu-

ble reactive phosphorus from 2.8 to 83.3 mg/L, and dissolved organic carbon reached a maximum of 460 mg/L. At any point in time these concentrations declined gradually with increasing depth within the hyperscum, and declined dramatically beneath the hyperscum. Similar patterns were recorded in another hyperscum in 1986. The chemical and temperature depth profiles indicated that free water movement took place around and under the hyperscum, but within it water movement was restricted to diffusion. Gas bubbles composed of 28% methane, 19% CO2, 53% N2, and traces of H2 trapped within the hyperscum, and the presence of volatile fatty acids in the interstitial water were indicative of anaerobic decomposition processes mediated by fermenting and methanogenic bacteria, and N:P ratios below 1.5 in the interstitial water suggested that nitrogen was lost as gas, possibly through denitrification. It is hypothesized that the major sites of decay of M. aeruginosa were the crust and the compact layer beneath it, while deeper within the hyperscum this cyanobacterium could survive prolonged periods of dark anaerobic conditions. (Author's abstract)
W90-08706

PHOSPHATASE ACTIVITY IN RELATION TO PHYTOPLANKTON COMPOSITION AND PH IN SWEDISH LAKES.

Uppsala Univ. (Sweden). Limnologiska Institutionen.
H. Olsson.
Freshwater Biology FWBLAB, Vol. 23, No. 2, p 353-362, April 1990. 2 fig, 2 tab, 42 ref.

Descriptors: *Acid rain effects, *Enzymes, *Hydrogen ion concentration, *Lakes, *Limnology, *Phytoplankton, *Sweden, Eutrophic lakes, Oligotrophic lakes, Phosphatases, Species composition.

Potential phosphatase activity and phytoplankton from several Swedish lakes of different character were compared in order to evaluate the importance of lake water pH and phytoplankton composition for the activity and pH optimum of lake water phosphatases. In oligotrophic lakes, in which phytoplankton biomass was most often dominated by Ochromonadaceae species, optimum phosphate activity was found at pH values <6. In eutrophic lakes, where species of Cyanophyceae and Bacillariophyceae dominated the phytoplankton biomass, optimum phosphatase activity was found at pH 7.5 or 8.5. The pH optimum of phosphatase activity often differed from the corresponding lake water pH. Experimental variation in phosphorus availability resulted in predictable changes in phosphatase activity. However, specific phosphatase activity, calculated per biomass of phytoplankton, was dependent on plankton species composition. (Author's abstract)
W90-08707

ENDLESS SUMMER: INTERNAL LOADING PROCESSES DOMINATE NUTRIENT CYCLING IN TROPICAL LAKES.

Michigan Univ., Ann Arbor. Dept. of Biology.
P. Kilham, and S. S. Kilham.
Freshwater Biology FWBLAB, Vol. 23, No. 2, p 379-389, April 1990.

Descriptors: *Africa, *Cycling nutrients, *Diatoms, *Lakes, *Paleolimnology, *Phosphorus, *Phytoplankton, *Silicon, *Tropical areas, Eutrophic lakes, Lake level, Mixing, Oligotrophic lakes, Stephanodiscus, Temperate zone.

Fossil diatom assemblages deposited in more than a dozen African lakes roughly 9500 years BP were dominated by a single planktonic species, Stephanodiscus astraea (Ehrenb.) Grun. These diatoms flourished when lake-levels were maximal. Because the ecological physiology of Stephanodiscus species is well known, one can predict the nutrient regime that must have existed when Stephanodiscus bloomed. Owing to competition for resources Stephanodiscus species dominate when the supply ratio of silicon to phosphorus (in moles) in the epiliminion is relatively low (Si:P approx. 1) Consequently, lakes dominated by S. astraea are often hypereutrophic. A series of hypotheses are proposed to explain why tropical lakes have decreas-

ing Si:P ratios as lake-levels increase, primarily owing to internal P-loading processes in the epilimnia. These observations appear to contradict present conceptions of the fundamental relationships governing nutrient loadings to and within lakes. Tropical lakes appear to have had increasing epilimnetic phosphorus loading as lake-levels increased. In contrast, large, deep lakes in the temperate zone are usually oligotrophic, with high Si:P ratios. It is concluded that regeneration rates are greater than removal rates for phosphorus in tropical lakes as compared to temperate lakes, especially where epilimnetic mixing exceeds 50 m. Biological control of the elemental cycles dominate in tropical lakes, whereas nutrient cycles in temperate lakes are dominated by physical processes for a large part of the year. This results in major differences in the fundamental mechanisms of nutrient regeneration and their relationships to morphometric features in the two regions. (Author's abstract)
W90-08708

PRODUCTION OF JUVENILE ATLANTIC SALMON, SALMO SALAR L., AND BROWN TROUT, SALMO TRUTTA L., WITHIN DIFFERENT SECTIONS OF A SMALL ENRICHED NORWEGIAN RIVER.

Rogaland Distriktshoegskole, Stavanger (Norway).
A. Bergheim, and T. Hesthagen.
Journal of Fish Biology JFIBA9, Vol. 36, No. 4, p 545-562, April 1990. 4 fig, 8 tab, 40 ref.

Descriptors: *Fish populations, *Norway, *Salmon, *Trout, Carrying capacity, Growth, Life history studies, Nutrients, Productivity, Regression analysis.

Growth, density and production of juvenile Atlantic salmon and brown trout were studied in three different sections of the Kvassheimsana River in south-western Norway from 1979 to 1983. Section 1, in the upper part of the river, is located above a waterfall impassable for migratory salmonids and is surrounded by grazing land. Sections 2 and 3, in the middle and lower parts the river, are influenced by agricultural activity. The number of 0+ salmon in sections 2 and 3 varied between 30.1 and 167.8 specimens/100 sq m, with means 90.2 and 95.2 specimens/100 sq m, respectively; the density of 1+ salmon, with mean values of 16.3 and 51.0 specimens/100 sq m, was significantly correlated with the original fry density. The growth rate of 0+ salmon was not inversely related to cohort density, but was significantly so for 1+ salmon. Mean annual salmon production in section 2 was 1595 g/100 sq m/y, and in section 3 was 841 g/100 sq m/y. A logarithmic function gave the best curve fit between salmon production and mean annual biomass. Thus, production leveled off for the highest values recorded in section 2, and perhaps approached the carrying capacity of the stream. A multiple regression analysis showed that yearly variation in it salmon density was the single factor accounting for most of the total variability in production (60%). Variation in water temperature and nutrient content were not significantly related to variation in fish production. Densities of brown trout were low in all sections (<20 specimens/100 sq m). Fry density was highest in section 3 and parr density in section 1. All age groups of sympatric brown trout grew significantly faster in sections 2 and 3 compared with allopatric brown trout in section 1. (Author's abstract)
W90-08709

ZOOPLANKTON-PHYTOPLANKTON INTERACTIONS IN A EUTROPHIC LAKE.

Department of Scientific and Industrial Research, Taupo (New Zealand). Taupo Research Lab.
M. R. James, and D. J. Forsyth.
Journal of Plankton Research JPLRD9, Vol. 12, No. 3, p 455-472, May 1990. 8 fig, 5 tab, 32 ref.

Descriptors: *Eutrophic lakes, *Limnology, *New Zealand, *Phytoplankton, *Zooplankton, Ammonia, Cyanophyta, Diatoms, Feeding rates, Predation, Seasonal variation.

Enclosure experiments were made in a cyanobacteria dominated lake (Lake Rotongaio in New Zealand) to assess the impact of zooplankton (>150 microm) grazing on algal growth rates and determine the effect of diel and vertical changes in zooplankton grazing intensity and nutrient (NH4-N) regeneration upon abundance of phytoplankton. The filamentous cyanobacterium Anabaena minutissima var. attenuata and diatom Cyclotella meneghiniana showed a negative linear change in abundance with a gradient in zooplankton grazing intensity. Phytoflagellates were not grazed and showed a positive linear change in abundance with increasing zooplankton biomass. These effects, as well as shortening of filament length of Anabaena, were caused by raptorial feeding by the calanoid copepod Boeckella propinqua which dominated the zooplankton. Phytoplankton growth was not stimulated by addition of nutrients, suggesting nutrient regeneration was not important. Diel and vertical changes in feeding and NH4-N regeneration rates were measured in March and June 1988. Diel differences were more pronounced in March when the water column was stratified. Specific feeding rates were more important than vertical changes in zooplankton biomass in determining community grazing rates in March, but in June when the water column was mixed, vertical distribution of zooplankton biomass was important. Zooplankton grazing was an important loss process for phytoplankton in the lower part of the epilimnion in Lake Rotongaio. (Author's abstract) W90-08710

EFFECTS OF LIGHT AND TEMPERATURE ON PHOTOSYNTHATE PARTITIONING IN ANTARCTIC FRESHWATER PHYTOPLANKTON.
British Antarctic Survey, Cambridge (England).
I. Hawes.
Journal of Plankton Research JPLRD9, Vol. 12, No. 3, p 513-518, May 1990. 4 fig, 1 tab, 11 ref.

Descriptors: *Antarctica, *Lakes, *Limnology, *Photosynthesis, *Phytoplankton, *Polar regions, Carbon fixation, Ice cover, Light, Seasonal variation, Temperature.

The effects of temperature and radiation flux on the partitioning of photosynthetically fixed carbon into four intracellular metabolic pools was investigated for natural phytoplankton assemblages from an Antarctic freshwater lake. At ambient temperature, protein synthesis was saturated at low photon flux densities (30-40 micromol/sq m/s) and above this flux fixed carbon was increasingly stored as lipid and polysaccharide. Increasing temperature raised both the saturated rate of protein synthesis and the photon flux at which saturation occurred. There was a corresponding decline in the accumulation of reserve products, particularly at low radiation fluxes. Phytoplankton survival in polar lakes depends on the ability to commence growth at low radiation fluxes and to retain viability over prolonged winter darkness. The pattern of photosynthesis seen in Sombre Lake is well adapted to meet these requirements. Maximal growth rates are attained at low radiation fluxes, comparable with those prevailing under ice cover, and cells may still accumulate storage products over the summer period which may be utilized over winter. The interactions between radiation flux, temperature, growth and accumulation of reserves may be vital to the survival of polar phytoplankton. (White-Reimer-PTT) W90-08711

SUCCESSIONAL DYNAMICS OF THE PHYTOPLANKTON IN THE LOWER PART OF THE RIVER EBRO.
Barcelona Univ. (Spain). Dept. de Ecologia.
S. Sabater, and I. Munoz.
Journal of Plankton Research JPLRD9, Vol. 12, No. 3, p 573-592, May 1990. 7 fig, 2 tab, 26 ref. CAICYT(project no. AC16/84) of the Ministry of Education and Science.

Descriptors: *Ebro River, *Phytoplankton, *Spain, Chlorophyta, Conductivity, Cyanophyta, Diatoms, Flow, Seasonal variation, Statistical analysis, Succession.

The temporal and spatial dynamics of phytoplankton have been studied in four sites located along the last 60 km of the river Ebro in Spain, over a period of 1 year. Diatoms and green algae were the most abundant groups; blue-green algae were frequent only in autumn. Asterionella formosa dominated the winter phytoplankton assemblages. In autumn, spring and early summer centric diatoms were dominant: Aulacoseira granulata (Ehr.) Simonsen in autumn; Cyclotella species, Skeletonema potamos (Weber)Hasle and Stephanodiscus species in spring. A great abundance of green algae was observed during the summer, mainly in the lower sites. In the sites closer to the mouth, the spring maximum of centric diatoms extended to the summer. Mainly in the downstream sites, a remarkable growth of Actinocyclus normanii f. subsalsa (Juhl.-Daunf.) Hustedt and Stephanodiscus hantzschii f. tenuis (Hust.)Hak. & Stoerm. was added to green algae in the late summer. By using a principal component analysis it was determined that the phytoplankton temporal succession and longitudinal differences between the sites may be affected by the variations in flow and the increase of water conductivity downstream; both factors seem to act together. The river is rather homogeneous with respect to the phytoplankton assemblages during the winter and spring months, and from late spring to the following autumn, differences greatly increased both over time and in downstream areas. (Author's abstract) W90-08712

PHYSIOLOGICAL AND ECOLOGICAL SCALINGS OF BODY SIZE IN AN OLIGOTROPHIC, HIGH MOUNTAIN LAKE (LA CALDERA, SIERRA NEVADA, SPAIN).
Malaga Univ. (Spain). Dept. de Ecologia.
J. Rodriguez, F. Echevarria, and F. Jimenez-Gomez.
Journal of Plankton Research JPLRD9, Vol. 12, No. 3, p 593-599, May 1990. 2 fig, 1 tab, 30 ref. Junta de Andalucia (Project no. 9/88), CICYT Project no. PPA86-0401, NATO Collaboration Research Grant no. 0732/88.

Descriptors: *Limnology, *Mountain lakes, *Oligotrophic lakes, *Plankton, *Spain, Body size, Community structure, Physiological ecology, Statistical analysis.

Relationships between individual organism size and abundance from picoplankton to mesozooplankton were examined in the planktonic community of an oligotrophic, high mountain lake (La Caldera) in Spain. The overall, time-integrated biomass spectrum showed a slope very close to zero. In addition, the presence of a discontinuity within the size range and the clear tendencies in the distribution of the residuals made the definition of an allometric model on this scale difficult. At the smaller scale of subgroups (pico-, nano-, micro-, and mesoplankton) there was a clear increase of biomass per unit water volume with body size. The subgroups identified in La Caldera closely correspond to the idea of trophic level and 'quasitaxonomic' groups because of the simplicity of the planktonic community. The results suggest that, at least in this small ecosystem, the ecological and evolutionary relationships which operate at the secondary scale are more important in structuring the community than the physiological factors (size-dependent metabolism) which determine the primary scaling. (Author's abstract) W90-08713

RE-OCCURRENCE OF FILAMENTOUS PLANKTONIC CYANOBACTERIA DURING PERMANENT ARTIFICIAL DESTRATIFICATION.
Fraunhofer-Inst. fuer Umweltchemie und Oekotoxikologie, Schmallenberg (Germany, F.R.).
C. Steinberg, and R. Tille-Backhaus.
Journal of Plankton Research JPLRD9, Vol. 12, No. 3, p 661-664, May 1990. 3 fig, 8 ref.

Descriptors: *Algal blooms, *Cyanophyta, *Destratification, *Eutrophic lakes, *Lake restoration, *Limnology, Bavaria, Depth, Limnothrix, Oscillatoria, Phosphorus removal, Succession.

In a small eutrophicated kettle lake (Lake Fischkaltersee, Iffeldorf Lake District, located south of the Lake Starnberger See, Upper Bavaria) artificial permanent destratification was carried out from 1980 to 1983 in order to remove cyanobacteria and to study mechanisms of phytoplankton succession on a whole lake scale. The filamentous planktonic cyanobacterium, Limnothrix (Oscillatoria) redekei (Van Goor), re-occurred at the end of the third year after a complete absence for two years. The cyanobacteria peaked at the end of the fourth year of permanent destratification; the biomass being much higher than during the pre-destratification period. The decreasing phosphorus contents of the lake indicate that the increasing densities of L. redekei is not just a matter of eutrophication. It has been shown recently that the presence of several Oscillatorial/Limnothrix species in lake phytoplankton does not necessarily indicate eutrophic or even polytrophic conditions. Whether or not oscillatorials can survive or even dominate under mixing conditions depends on mixing depth, euphotic depth and the ratio of both, provided that biotic factors such as changes in zooplankton populations, can be excluded. (White-Reimer-PTT) W90-08714

RESOURCE COMPETITION OF HERBIVOROUS ZOOPLANKTON: A REVIEW OF APPROACHES AND PERSPECTIVES.
Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.).
K. O. Rothhaupt.
Archiv fuer Hydrobiologie AHYBA4, Vol. 118, No. 1, p 1-29, March 1990. 12 fig, 116 ref.

Descriptors: *Feeding rates, *Food chains, *Life history studies, *Limnology, *Reviews, *Competition, *Zooplankton, Aquatic habitats.

Resource competition is an indirect interaction, affecting the competitors via the exploitation of common food sources. The traditional phenomenological view of competition is presently being replaced by mechanistic concepts, thus opening the way to take advantage of knowledge of zooplankton physiology, life histories, and feeding modes. Ten hypotheses of zooplankton competition have been proposed, five entirely based on assumptions about resource use, five involving other than merely resource related aspects. According to the size-efficiency hypothesis, large bodied zooplankters (mainly cladocerans) are superior resource users. The hypothesis of the superiority of small zooplankton assumes that small species have an advantage when food is limiting. The r-max hypothesis is based on the assumption that maximal growth rates and competitive ability are positively correlated. The threshold hypothesis sees those species superior that have the lowest resource requirement to persist under the given circumstances. Abundance patterns of herbivorous zooplankton can be explained by interspecific differences in resource use. Zooplankton avoid competition by spatial-temporal niche separation. Different life-histories and population time lags play an important role in competitive interactions of herbivorous zooplankton. There is no competitive exclusion, because changing biotic and abiotic conditions prevent steady state and reverse or shift competitive superiority. Competitive ability is correlated with susceptibility to predation, so as to permit coexistence in the presence of predators. Inferior competitors are superior colonizers in temporary habitats, and local extinctions can thus be balanced by recolonization of reestablished habitats. The concepts of threshold food concentrations, of resource partitioning due to different feeding modes, and of the effects of resource variance are regarded to be the most promising approaches. (Author's abstract) W90-08722

EFFECTS OF WIND-INDUCED TURBULENCE AND ALGAL MAT DEVELOPMENT ON EPILITHIC DIATOM SUCCESSION IN A LARGE RESERVOIR.
Louisville Univ., KY.
C. G. Peterson, and K. D. Hoagland.
Archiv fuer Hydrobiologie AHYBA4, Vol. 118,

Group 2H—Lakes

No. 1, p 47-68, March 1990. 5 fig, 5 tab, 53 ref.

Descriptors: *Algal physiology, *Limnology, *Species composition, *Succession, *Turbulence, *Water temperature, *Wind, *Wind-driven currents, Cyanobacteria, Diatoms, Population dynamics.

Development of an epilithic algal community was monitored over a 36-day period in Lake McConaughy to examine the factors which affect diatom succession in this system, such as ambient wind patterns, temperature, and autogenic changes that accompany increases in mat thickness. Epilithic algal communities developed rapidly on clay tiles to a 2-cm thick, taxonomically-stratified mat covered by filamentous blue-green algae (Oscillatoria) within 18 days. Relative abundances of mid-successional taxa were higher in blue-green surface layers than in deeper areas of the mat and were significantly correlated with Oscillatoria biovolume which suggested that development of blue-green surface layers altered environmental conditions within the community. Abrupt shifts in diatom species composition on tiles were not correlated to changes in ambient wind patterns or water temperature, and were probably more closely related to autogenic changes within the community. Changes in wind direction and velocity were, however, correlated with more subtle variations in benthic diatom relative-abundance patterns. Variation in diatom densities and species composition in sediment traps collected at 3-day intervals was strongly correlated with wind patterns, which indicated that wind-generated turbulence significantly affected diatom immigration pools. A large storm on day 29 reduced diatom densities on tiles by 92%, altered diatom relative abundance patterns, and increased cell sedimentation rates nearly fivefold. Diatom species were differentially affected by this storm based on differences in morphology, growth form, and spatial distribution within mature epilithic algal mats. (Author's abstract)
W90-08723

OPTICAL PROPERTIES OF GAS-VACUOLATE CELLS AND COLONIES OF MICROCYSTIS IN RELATION TO LIGHT ATTENUATION IN A TURBID, STRATIFIED RESERVOIR (MOUNT BOLD RESERVOIR, SOUTH AUSTRALIA).
Adelaide Univ. (Australia). Dept. of Botany.
G. G. Ganf, R. L. Oliver, and A. E. Walsby.
Australian Journal of Marine and Freshwater Research AJMFA4, Vol. 40, No. 6, p 595-611, 1989. 9 fig, 5 tab, 44 ref.

Descriptors: *Algal physiology, *Chlorophyll, *Light penetration, *Limnology, *Optical properties, *Turbidity, Downwelling, Irradiance, Light absorption, Light scattering, Upwelling.

Profiles of downwelling and upwelling irradiance were measured in a stratified, turbid reservoir, when Microcystis aeruginosa formed a significant proportion of the phytoplankton community. The attenuation coefficient was approximately 2.1/m and the reflectance approximately 0.03. Application of Kirk's simulation model relating apparent and inherent optical properties enabled calculation of coefficients of absorption(1.3 to 1.6/m) and scattering (5-7/m). The asymptotic diffuse backscattering coefficient (0.2/m) was derived from a slight modification of Kirk's original equation. Turbidity measurements supported the general rule that nephelometric turbidity was numerically equivalent to the scattering coefficient. There was good agreement between the measure light profile and one reconstructed from optical properties. The optical properties of cells and colonies of Microcystis were investigated before and after the collapse of gas vacuoles. The chlorophyll a-specific absorption coefficient for cells (0.0138 sq m/mg of chlorophyll a) was decreased with increasing depth as the spectral composition changed. The chlorophyll a-specific scattering coefficient for vacuolate cells (0.14 sq m chlorophyll a) was greater than for colonies (0.11 sq m chlorophyll a) and a similar correspondence occurred for non-vacuolate cells and colonies (0.029 and 0.020 sq m chlorophyll a respectively). These measurements illustrate the package effect and also that approximately 80% of the scattering is due to gas vacuoles. The relationship between pressure-sensitive turbidity and gas-vacuole volume suggested that 1 microliter/ml was equivalent to a turbidity of 2 NTU. These optical characteristics, combined with the buoyant nature of Microcystis, suggest that it is a canopy species. (Author's abstract)
W90-08726

NUTRIENT CONCENTRATION-FLOW RELATIONSHIPS AND LOADS IN THE SOUTH PINE RIVER, SOUTH-EASTERN QUEENSLAND. I. PHOSPHORUS LOADS.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
P. R. Cosser.
Australian Journal of Marine and Freshwater Research AJMFA4, Vol. 40, No. 6, p 613-630, 1989. 3 fig, 11 tab, 33 ref.

Descriptors: *Limiting nutrients, *Nutrient concentrations, *Nutrient transport, *Phosphorus, Australia, Rivers, Runoff, Stormflow.

Total phosphorus (TP), particulate phosphorus (PP), and total dissolved phosphorus (TDP) were monitored over 24 months in the South Pine River, southeastern Queensland. The sampling interval ranged from 13-16 days during baseflow to less than 30 minutes during stormflow. Baseflow TP concentrations were relatively constant at 0.03 mg/L. During stormflow, concentrations of both TDP and PP increased significantly and were positively correlated with flow. TP loads were 8950 kg (56.7 kg/sq km/year) and 3980 kg (25.2 sq kg/year) in 1984 and 1985 respectively. Annual load was influenced by both the absolute discharge volume and the relative proportion of stormflow. PP was the dominant phosphorus fraction, comprising 77% of the TP load. Approximately 86, 89 and 75% of the TP, PP, and TDP loads, respectively, were carried in only 2.8% of the time (20 days) during three major storms (50.8% of total flow). Concentrations and exports were high relative to those reported in other Australian studies, suggesting that climatic factors, particularly rainfall intensity, are important in determining export. As a result of the variability in unit area export attributable to variations in runoff, unit area export coefficients are of negligible use for predictive purposes. However, by expressing load in terms of mass per unit runoff per unit area (kg/mm/sq km), variances attributable to discharge is removed. When expressed in this form, stormflow export was relatively constant (0.46-0.54 kg/mm/sq km). (Author's abstract)
W90-08727

EVALUATION OF TRANSPORT AND STORAGE OF (60)CO, (134)CS, (137)CS AND (65)ZN BY RIVER SEDIMENTS IN THE LOWER SUSQUEHANNA RIVER.
Maryland Dept. of Natural Resources, Annapolis. Power Plant and Environmental Review Div.
For primary bibliographic entry see Field 5B.
W90-08731

INTERACTION BETWEEN AMMONIUM AND NITRATE UPTAKE IN PHYTOPLANKTON.
Louisiana Universities Marine Consortium, Chauvin.
For primary bibliographic entry see Field 2L.
W90-08745

DOWN BY THE RIVER: THE IMPACT OF FEDERAL WATER PROJECTS AND POLICIES ON BIOLOGICAL DIVERSITY.
For primary bibliographic entry see Field 6G.
W90-08746

PROTECTING NONTIDAL WETLANDS.
Maryland Dept. of Natural Resources, Annapolis. Nontidal Wetlands Div.
D. G. Burke, E. J. Meyers, R. W. Tiner, and H. Groman.
American Planning Association, Planning Advisory Service, Report No. 412/413, December 1988. 76p, 7 fig, 6 tab, 59 ref.

Descriptors: *Administrative regulations, *Environmental protection, *Marshes, *Regulations, *Swamps, *Wetlands, Drainage, Federal jurisdiction, Flooding, Public policy, State jurisdiction.

In recent years, public understanding of the importance of nontidal wetlands has grown, but many people still remain unaware of the value of these areas. Marshes, swamps, and other wetlands are actually assets to society. They provide numerous products for man's use and consumption, protect private property, help improve water quality, and provide opportunities for recreation and enjoyment of nature's beauty. Destruction or alteration of wetlands eliminates or diminishes these values. Drainage of wetlands, for example, eliminates all their beneficial effects on water quality and directly contributes to flooding problems. This report describes wetland types and values and includes a look at: the current status of wetlands in the United States; how to create a wetland protection program; and, federal, state, and local regulations designed to protect nontidal wetlands. (Lantz-PTT)
W90-08757

PROCEEDINGS OF THE SYMPOSIUM ON HEADWATERS HYDROLOGY.
For primary bibliographic entry see Field 2E.
W90-08822

NATIONAL FOREST SYSTEM: AMERICA'S HEADWATERS.
Lolo National Forest, Missoula, MT.
For primary bibliographic entry see Field 6D.
W90-08823

BRIEF HISTORY OF WILDERNESS WATER POLICY IN THE UNITED STATES.
Kansas State Univ., Manhattan. Dept. of Landscape Architecture.
For primary bibliographic entry see Field 6E.
W90-08824

VARIABLE LANDSCAPE AGGREGATION FOR LARGE SCALE WATERSHED EVAPOTRANSPIRATION ESTIMATES.
Montana Univ., Missoula. School of Forestry.
For primary bibliographic entry see Field 2D.
W90-08830

ARCTIC GRAYLING COEXIST WITH DAM SAFETY IMPROVEMENTS.
HKM Associates, Billings, MT.
For primary bibliographic entry see Field 8I.
W90-08831

COPE RESEARCH ON RIPARIAN ZONE MANAGEMENT IN THE OREGON COAST RANGE.
Environmental Research Lab.-Narragansett, Newport, OR. Mark O. Hatfield Marine Science Center.
For primary bibliographic entry see Field 5G.
W90-08851

CONTROL OF ATTACHED ALGAE BY NITROGEN AND PHOSPHORUS IN THE CLARK FORK RIVER.
Montana Univ., Missoula.
For primary bibliographic entry see Field 5C.
W90-08852

HYDROLOGIC CHARACTERISTICS OF A WETLAND USING A BROMIDE TRACER.
Peccia (Robert) and Associates, Helena, MT.
For primary bibliographic entry see Field 5B.
W90-08877

STOCHASTIC MODELING OF LAKE LEVELS FOR A MANAGEMENT DECISION.
Forest Service, Washington, DC.
R. M. Solomon, and L. J. Schmidt.

IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 627-636, 5 fig, 1 tab, 6 ref.

Descriptors: *Closed lakes, *Headwaters hydrology, *Stochastic models, *Water level, *Water management, Hydrologic budget, Model studies, Monte Carlo method.

An approach for simply modeling stochastic processes for a management decision, is presented. The case example uses a closed basin to demonstrate use of a deterministic model operated with stochastic data. Monte Carlo distributions provide input variables for a simple water balance model. Dependent runoff input variables were regressed with the independent climatic variables to generate a stochastic front-end for modeling the water budget of a closed basin lake. Model runs made for over 100 years of stochastically generated input data are summarized graphically to describe benefits and consequences of management decisions. (See also W90-08822) (Author's abstract)
W90-08885

IMPACT OF ACID MINE DRAINAGE ON BENTHIC MACROINVERTEBRATES (PLECOPTERA) IN A MONTANE STREAM.
Montana Univ., Missoula.
For primary bibliographic entry see Field 5C.
W90-08887

USE OF A HYDRAULIC POTENTIOMANOMETER TO DETERMINE GROUND-WATER GRADIENTS IN A WETLAND, COLORADO.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2F.
W90-08890

REVISED EDITION OF A COMPUTERIZED PLANKTON COUNTER FOR PLANKTON, PERIPHYTON, AND SEDIMENT DIATOM ANALYSES.
National Museum of Natural Sciences, Ottawa (Ontario). Botany Div.
For primary bibliographic entry see Field 7C.
W90-08896

EXPERIMENTAL STUDY OF THE EFFECTS OF FISH ZOOPLANKTIVORY ON THE PHYTOPLANKTON OF A BRAZILIAN RESERVOIR.
British Columbia Univ., Vancouver. Dept. of Zoology.
T. G. Northcote, M. S. Arcifa, and K. A. Munro.
Hydrobiologia HYDRB8, Vol. 194, No. 1, p 31-45, 1990. 6 fig, 5 tab, 29 ref. NSERC Scientific Exchange Award and Operating Grant 58-3454.

Descriptors: *Biomass, *Ecosystems, *Fish behavior, *Food chains, *Grazing, *Limnology, *Phytoplankton, *Zooplankton, Americana Reservoir, Brazil, Cladocerans, Daphnia, Reservoirs, Sao Paulo, Species composition, Temporal variation.

Two short-term (4-5 week) sets of enclosure experiments were conducted during 'winter' periods (1982 and 1983) in Americana Reservoir near Sao Paulo, Brazil, to test effects of fish predation reducing grazing pressure by large cladoceran zooplankton (mainly Daphnia gessneri) on phytoplankton density, cell size distribution, biomass, species composition and richness. Two enclosures were stocked with the zooplanktivorous characin fish Astyanax while two others remained fishless during each set of experiments. Within two weeks or less, phytoplankton cell density and biomass were significantly reduced in the fishless enclosures, particularly in the small cell size (<15 micrometer) fraction. Changes also occurred in species composition and richness. These shifts generally were maintained or intensified during the course of the experiment. (Author's abstract)
W90-08897

CHEMICAL STRATIFICATION AND PARTIAL MEROMIXIS IN RESERVOIRS IN TASMANIA.

Tasmania Univ., Hobart (Australia). Dept. of Botany.
L. C. Bowling, and P. A. Tyler.
Hydrobiologia HYDRB8, Vol. 194, No. 1, p 67-83, 1990. 11 fig, 3 tab, 21 ref.

Descriptors: *Chemical stratification, *Limnology, *Reservoirs, *Tasmania, *Thermal stratification, *Water circulation, Bicarbonates, Conductivity, Hydrogen ion concentration, Iron, Lake Barnington, Lake Murchison, Lake morphology, Magnesium, Manganese, Meromixis, Seasonal variation, Water temperature.

During the first summer after impoundment, chemical stratification occurred in four deep, steep-sided reservoirs of the Pieman River Power Development, Tasmania, under the influence of thermal stratification and anoxic hypolimnia caused by decaying vegetation in the flooded river valleys. Marked increases occurred in temperature, conductivity, and pH, and in concentrations of dissolved iron, manganese, calcium, magnesium, and bicarbonate in the reducing waters which accumulated as monimolimnetic pools adjacent to the dams. This partial, incipient meromixis persisted only in Lake Murchison, where a shallow monimolimnetic pool remained three years later. In the other reservoirs of the Pieman scheme it decayed after one or two years. Reservoir morphometry, degree of shelter, nature of major inflows, and alignment with respect to prevailing winds, are primary factors determining the persistence or eventual decay of chemical stratification in the respective impoundments. In Lake Barrington, another meromictic Tasmanian reservoir, the initial chemical gradient decayed and virtually disappeared, but was reestablished with greater severity than on any previous occasion. The severity of partial meromixis may wax and wane in relation to seasonal or longer-term meteorological events. (Author's abstract)
W90-08898

USE OF 15-N/14-N RATIOS TO EVALUATE THE FOOD SOURCE OF THE MYSID, NEOMYSIS INTERMEDIA CZERNIAWSKY, IN A EUTROPHIC LAKE IN JAPAN.
Tokyo Univ. (Japan). Dept. of Botany.
H. Toda, and E. Wada.
Hydrobiologia HYDRB8, Vol. 194, No. 1, p 85-90, 1990. 3 fig, 3 tab, 24 ref.

Descriptors: *Eutrophic lakes, *Food chains, *Limnology, *Nitrogen cycle, *Nitrogen radioisotopes, *Nutrients, *Opossum shrimp, *Sediment chemistry, Japan, Lake Kasumiguara, Organic matter, Phytoplankton, Seasonal variation, Zooplankton.

Stable isotope ratios of nitrogen were measured in the mysid, Neomysis intermedia, together with various biogenic materials in a eutrophic lake, Lake Kasumiguara, in Japan for the period 1984-1985. The mysid, particulate organic matter (POM, mostly phytoplankton) and zooplankton showed a clear seasonal change in delta 15-N with high values in spring and fall, but the surface bottom did not. A year to year variation as well as seasonal change in delta 15-N was found in the mysid. The annual averages of delta 15-N of each material collected are as follows: surface bottom mud, 6.3 ppt (range: 5.7-6.9 ppt); POM, 7.9 ppt (5.8-1.18 ppt); large sized mysid 11.6 ppt (7.7-14.3 ppt); zooplankton. 12.5 ppt (10.0-16.4 ppt); prawn, 13.2 ppt (9.9-15.4 ppt); goby, 15.1 ppt (13.8-16.7 ppt). The degree of 15-N enrichment by the mysid was determined as 3.2 ppt by the laboratory rearing experiments. The apparent parallel relationship between the POM and the mysid in the temporal patterns of delta 15-N with about 3 ppt difference suggests the POM as a possible food source of N. intermedia in this lake throughout the year. (Author's abstract)
W90-08899

STUDIES ON DECOMPOSITION OF CERATOPHYLLUM DEMERSUM LITTER UNDER LABORATORY AND FIELD CONDITIONS: LOSSES OF DRY MASS AND NUTRIENTS, QUALITATIVE CHANGES IN ORGANIC COM-

POUNDS AND CONSEQUENCES FOR AMBIENT WATER AND SEDIMENTS.
Limnologisch Inst., Nieuwersluis (Netherlands). Vijverhof Lab.
E. P. H. Best, J. H. A. Dassen, J. J. Boon, and G. Wiegers.
Hydrobiologia HYDRB8, Vol. 194, No. 2, p 91-114, 1990. 9 fig, 5 tab, 32 ref.

Descriptors: *Aquatic plants, *Biomass, *Decomposition, *Detritus, *Ecosystems, *Limnology, *Nutrients, *Organic matter, Aquatic bacteria, Carbon, Energy transfer, Nitrogen, Oxygen, Phosphorus, Phytoplankton, Sediment chemistry, Water temperature.

Ceratophyllum demersum was studied over a 17-day period under controlled conditions of temperature and oxygen and over a 169-day period in the field in Lake Vechten, the Netherlands. Litter, water and sediment were sampled on the 0, 2, 4, 7 and 17th day under controlled conditions and on the 0, 17, 49, 127, and 169th day in the field. The litter was analyzed quantitatively for dry mass, ash, carbon, nitrogen, phosphorus and qualitatively for organic composition by pyrolysis mass spectrometry. The water was analyzed for concentrations of organic carbon (total and dissolved), nitrogen (total, ammonia, and particulate) and phosphorus (total and orthophosphate), for the concentrations of nitrogen, carbon and phosphorus, and for bacterial numbers. The pattern of litter mass loss fitted an exponential model fairly well. Mass decreased far less in the field than under controlled conditions. Carbon, nitrogen, and phosphorus left the litter initially largely in particulate form, recoverable in the water. The ratio of dissolved to total nutrient concentration was lower under controlled aerobic than under anaerobic conditions. Increasing temperature stimulated bacterial use of organic carbon and nitrogen. A rapid nutrient flow occurred from macrophyte litter, via water, to sediment. Phytoplankton biomass in the water was greatly stimulated by substances freed from the decomposing litter. Diatoms increased more than green algae, predominating alternately with green algae under aerobic conditions and continuously under anaerobic conditions. Bacteria in the water initially increased, partly due to transgression from the sediment-water interface to the water and partly due to an actual increase in community biomass. Bacteria returned largely to the sediment-water interface, stimulated by increasing temperature, as most of the substrate readily usable by them had left the litter in the litter bag and was associated with the upper sediment layers. (Brunone-PTT)
W90-08900

GRAZING AND ASSIMILATION RATES OF NATURAL POPULATIONS OF PLANKTONIC ROTIFERS KERATELLA COCHLEARIS, KERATELLA QUADRATA, AND KELLICOTTIA LONGISPINA IN A EUTROPHIC LAKE (AYDAT, FRANCE).
Clermont-Ferrand-2 Univ., Aubiere (France). Lab. d'Hydrobiologie.
N. Lair, and H. Oulad Ali.
Hydrobiologia HYDRB8, Vol. 194, No. 2, p 119-131, 1990. 10 fig, 1 tab, 28 ref.

Descriptors: *Assimilative capacity, *Carbon radioisotopes, *Eutrophic lakes, *Food chains, *Grazing, *Lake Aydat, *Rotifers, France, Limnology, Phytoplankton, Seasonal variation, Water quality, Zooplankton.

The filtering rates of carbon-14 labelled Chlamydomonas sp. by three dominant species of rotifers were studied in eutrophic Lake Aydat. They varied from 4 to 53 microL/individual/hr for Keratella cochlearis, from 2 to 56 microL/individual/hr for Keratella quadrata and from 3 to 52 microL/individual/hr for Kellicottia longispina. Their maximum assimilation efficiency was 32%. At the measured grazing rates, these populations could clear the water in less than two days during July. In Lake Aydat, the rotifer community could play an important role in the regulation of seasonal succession of phytoplankton and bacteria. (Author's abstract)

W90-08901

WHY IS THE STREAM FAUNA OF SOUTH-WESTERN AUSTRALIA SO IMPOVERISHED.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
S. E. Bunn, and P. M. Davies.
Hydrobiologia HYDRB8, Vol. 194, No. 2, p 169-176, 1990. 1 tab, 49 ref.

Descriptors: *Aquatic animals, *Australia, *Ecosystems, *Species diversity, *Stream biota, Arid climates, Fish, Invertebrates, Primary productivity.

For many years, the stream fauna of temperate Australia was believed to have a reduced diversity in comparison with that of temperate streams in the Northern Hemisphere. In contrast, studies of the stream fauna of southwestern Australia have revealed a greatly reduced diversity, even in comparison with that of southeastern Australia. Conditions of climatic predictability should be conducive to the formation of highly structured, diverse stream communities, and yet this has not occurred. Streams in southwestern Australia have a depauperate invertebrate and fish species diversity due possibly to the: insular nature of the southwestern part of Australia; a previous history of greater aridity in the area; and an extremely low level of primary productivity. (Brunone-PTT)
W90-08902

INFLUENCE OF OVERWINTERING DAPHNIA ON SPRING ZOOPLANKTON COMMUNITIES: AN EXPERIMENTAL STUDY.
National Inst. for Environmental Studies, Tsukuba (Japan). Environmental Biology Div.
T. Hanazato, and M. Yasuno.
Ecological Research (Kyoto) ECRSEX, Vol. 4, No. 3, p 323-338, December 1989. 9 fig, 1 tab, 45 ref.

Descriptors: *Daphnia, *Limnology, *Population dynamics, *Seasonal variation, *Species composition, *Zooplankton, Cladocerans, Competition, Overwintering, Resting eggs, Rotifers.

To evaluate the influence of overwintering individuals of zooplankton on spring zooplankton communities, the dynamics of zooplankton communities with or without overwintering individuals were observed in experimental ponds from fall to spring. An insecticide, carbaryl, was used to regulate the overwintering individuals. In ponds which received insecticide application in November or January, all cladoceran and rotiferan species were eliminated by the treatments and did not reappear until late March or early April, even when the chemical disappeared rapidly. The low water temperature may have delayed the establishment of the populations from resting eggs. In these ponds, populations of various cladocerans and rotiferan species, which seemed to be originated from resting eggs, were built up in the spring. In control populations, Daphnia ambigua or D. longispina overwintered as juveniles and adults and established a large spring population earlier than the other cladocerans and rotifers overwintering as resting eggs. The zooplankters from resting eggs did not increase in the spring probably because their growth was suppressed by the preceding Daphnia species through competition. Even if the number of overwintering individuals is small, they may have a potential to build up a large population earlier than the individuals hatching from resting eggs. As a result, the species which have overwintered as individuals seem to predominate in the spring and have a large influence on the spring zooplankton community. (Author's abstract)
W90-08938

UPWELLING LIGHT STREAM IN NATURAL WATERS.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Plant Industry.
For primary bibliographic entry see Field 1A.
W90-08965

NUMERICAL MODEL FOR THE COMPUTATION OF RADIANCE DISTRIBUTIONS IN NATURAL WATERS WITH WIND-ROUGHENED SURFACES.
Joint Inst. for the Study of the Atmosphere and Ocean, Seattle, WA.
C. D. Mobley.
Limnology and Oceanography LIOCAH, Vol. 34, No. 8, p 1473-1483, December 1989. 6 fig, 2 tab, 11 ref. Office of Naval Research Contract N00014-87-K-0525.

Descriptors: *Light penetration, *Model studies, *Radiance distribution, Depth, Mathematical studies, Natural waters, Numerical analysis, Optical properties, Wavelengths, Wind waves.

A numerical technique is presented for computing radiance distributions in natural water that have wind-blown surfaces and depth-dependent inherent optical properties. Input to the numerical model consists of the radiance distribution incident on the air-water surface from above, the wind velocity, which specifies the state of randomness of the air-water surface via a wind speed-wave slope spectrum, the volume scattering and volume attenuations functions of the water body as functions of depth and wavelength, and the type of bottom boundary. Primary output from the model consists of directionally discretized radiances as functions of wavelength, direction, and depth throughout and above the water body. (Author's abstract)
W90-08966

SPECTRAL REFLECTANCE AND WATER QUALITY OF ADIRONDACK MOUNTAIN REGION LAKES.
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
F. A. Vertucci, and G. E. Likens.
Limnology and Oceanography LIOCAH, Vol. 34, No. 8, p 1656-1672, December 1989. 4 fig, 2 tab, 71 ref.

Descriptors: *Acid rain effects, *Acidification, *Adirondack Mountains, *Lakes, *Light penetration, *Remote sensing, *Water quality, Aluminum, Coastal Zone Color Scanner, Dissolved organic carbon, Hydrogen ion concentration, Performance evaluation, Pigments, Reflectance, Regression analysis, Spectral analysis, Suspended solids, Wavelengths.

The reflectance properties of lakes in the Adirondack mountain region were investigated. Five distinct types of reflectance spectra are identified and related to differences in water quality. No relationship was found between reflectance and acidification status. A reflectance model based on literature absorbance and scattering cross-sections of water, plant pigments, dissolved organic carbon (DOC), and suspended inorganic matter is used to generate reflectance spectra of each reflectance type. use of a variable Q (measured angular distribution) factor during the conversion of remotely sensed reflectance to irradiance reflectance improves the correspondence between measured and modeled irradiance reflectance spectra. Comparison of measured reflectance with model reflectance also demonstrates the importance of small concentration changes as well as the interactive influence of plant pigments, DOC, and suspended matter on lake color. Correlograms depict the wavelength-dependent relationships between reflectance and water quality. Plant pigments, DOC, and suspended material are correlated negatively with reflectance from 400 to 600 nanometer (nm) and correlated positively from 600 to 750 nm. Parameters associated with lake acidification (pH, alkalinity, and Al concentration) are correlated poorly with reflectance. Adirondack lakes exhibit a high degree of covariance between pigment, DOC, and suspended matter concentrations. Regression models predicting total pigments and DOC suggest that these parameters can be estimated remotely in these lakes, but remote estimation of pH, alkalinity, and Al is not possible with reflectance measures. A regression model estimating total pigments from the reflectance ratio 525:554 nm is similar in slope and accuracy to one derived for the Coastal Zone Color Scanner (CZCS) for coastal marine waters. (Author's abstract)

W90-08969

ORIGIN AND DEVELOPMENTAL HISTORY OF MINNESOTA LAKES.
H. E. Wright.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 26-31, Fall 1989. 4 fig, 9 ref.

Descriptors: *Glacial lakes, *Lake morphology, *Lake sediments, *Lakes, *Land use, *Limnology, *Minnesota, *Paleolimnology, Paleoclimatology, Palynology, Pollen.

Most lakes in Minnesota owe their origin directly or indirectly to glacial deposition or erosion 10,000 to 20,000 years ago. The shapes of the lakes have since been modified by waves and currents near the shores and by the deposition of sediment offshore, principally the sediment produced by growth of algae and other organisms. This sediment is a receptacle for pollen grains blown into the lake from the surrounding vegetation, and the stratigraphic succession of pollen grains records the postglacial vegetational and thus climatic history of the area. The sediment also preserves the fossils of microorganisms that reveal by their chemical composition the record of past changes in salinity, which in turn is related to water levels and thus to climate. Pollen analysis, diatom analysis, and sediment chemistry indicate that the mid-postglacial period was significantly warmer and drier than the present. Knowledge of the natural prehistoric processes in lakes and landscapes as recorded in lake sediments provide a perspective for evaluating the effects of modern land use and pollution on the chemical and biological processes in lakes, and it may assist in plans for improving their water quality and management. (Author's abstract)
W90-08973

DISTRIBUTION OF MINNESOTA FISHES AND LATE PLEISTOCENE GLACIATION.
Minnesota Univ., Minneapolis. Dept. of Ecology and Behavioral Biology.
J. C. Underhill.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 32-37, Fall 1989. 1 tab, 34 ref.

Descriptors: *Fish, *Fish migration, *Glacial lakes, *Glacial streams, *Lakes, *Limnology, *Minnesota, *Paleolimnology, Glacier surges.

The fishes of Minnesota have been the focus of research for almost a century. At present the ichthyofauna totals 153 species belonging to 19 families, including 13 species which have been introduced. Because Minnesota was covered by glacial ice until at least late Wisconsinan time, species that migrated into the state from the periglacial region could have been derived from three refugia: unglaciated Alaska, the Atlantic refugium, and the lower Mississippi River refugium. The routes followed in their dispersal were dependent upon the drainage connections that existed during late Pleistocene and early Holocene time. Fish migration paths were largely determined by the formation of large glacial lakes such as Lake Agassiz, Lake Koochiching, Lake Duluth, and Lake Ontonagon. Advances and retreats of various glacial lobes controlled the size and drainage directions of the glacial lakes, allowing migration of fishes from different refugia at different times. The geologic evidence for Holocene drainage is more conjectural, and the present distribution of species can be used to infer changes in drainage during this period of time. (Tappert-PTT)
W90-08974

REGIONAL NATURE OF LAKE WATER QUALITY ACROSS MINNESOTA: AN ANALYSIS FOR IMPROVING RESOURCE MANAGEMENT.
Minnesota Pollution Control Agency, Roseville. Div. of Water Quality.
S. A. Heiskary, and C. B. Wilson.
Journal of the Minnesota Academy of Science

JMNAAC, Vol. 55, No. 1, p 71-77, Fall 1989. 4 fig, 3 tab, 26 ref.

Descriptors: *Eutrophic lakes, *Eutrophication, *Lake management, *Land use, *Minnesota, *Phosphorus, *Water pollution effects, *Water quality management, Phosphorus compounds, Recreation, Regional planning, Secchi disks, Transparency.

The diversity and number of lakes in Minnesota may be better understood by the use of regional characterizations of lake and watershed information. Recent efforts have utilized the ecoregion approach to define seven regions across Minnesota, four of which contain 98 percent of the lake resources. Ecoregions are areas of relative homogeneity that were developed from mapped information concerning land use, soils, land and surface form, and potential natural vegetation. Typical land use patterns vary regionally as do lake water quality patterns. Understanding these patterns will assist lake managers to develop realistic goals and minimize false expectations. The average summer surface water concentration of total phosphorus was used to develop regional assessments to facilitate the definition of reasonable goals, expressed in terms of: average summer nutrient concentrations, probability of nuisance conditions (e.g., estimates of algal bloom frequency), and probability of Secchi transparency ranges for lake resources management, for protective as well as restorative purposes. User perceptions of water quality also may be used to define swimmable conditions to assist in goal setting by lake resource managers. (Author's abstract)
W90-08980

WATER QUALITY AND MANAGEMENT OF LAKES IN THE TWIN CITIES METROPOLITAN AREA.
Metropolitan Council, St. Paul, MN.
For primary bibliographic entry see Field 5G.
W90-08981

NATURAL AND ANTHROPOGENIC FORCES ACTING ON A FOREST LAKE.
Minnesota Univ.-Duluth. Dept. of Biology.
M. C. Whiteside, M. B. King, and K. Pulling.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 81-85, Fall 1989. 2 fig, 2 tab, 12 ref. NSF Grant BSR-8421160.

Descriptors: *Air temperature, *Fish, *Fish populations, *Lake Itasca, *Lake fisheries, *Limnology, *Minnesota, Bluegills, Crappie, Forests, Phytoplankton, Pike, Sport fishing, Zooplankton.

Lake Itasca, Minnesota is located within one of the more popular state parks. It is within a natural setting of northern coniferous and deciduous hardwoods. Since the turn of the century, logging, fire protection, and development within the watershed have put modest pressures on the ecosystem. The presence of the University of Minnesota's Biological and Forestry Station on the lake has encouraged research in this region. Consequently there are numerous research reports and papers which are available at the station's library. An examination of temperature data collected during May between 1962 and 1987 indicated that average temperatures during May have been warmer from 1975-1987 than 1962-1974. A review of research reports collected over the past 25 years indicated no changes in phytoplankton, macrophyte, zooplankton, or zoobenthos communities, but changes have occurred in four species of the fish community, including bluegill, walleye, black crappie and northern pike. The decrease in gamefish such as walleye has been attributed to heavy sportfishing. There is evidence for warmer temperatures during a critical period (May) for most aquatic animals. If true, it will affect the biotic interactions to the extent of shifting the equilibrium of the lake. (Tappert-PTT)
W90-08982

LAKE MIXING DYNAMICS AND WATER QUALITY MODELS.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 5G.
W90-08983

SUSCEPTIBILITY OF NORTHERN MINNESOTA LAKES TO ACID DEPOSITION IMPACTS.
For primary bibliographic entry see Field 5B.
W90-08984

MERCURY IN FISH FROM NORTHEASTERN MINNESOTA LAKES: HISTORICAL TRENDS, ENVIRONMENTAL CORRELATES, AND POTENTIAL SOURCES.
For primary bibliographic entry see Field 5B.
W90-08985

FISHERIES AND ENVIRONMENTAL RESEARCH BY THE MINNESOTA SEA GRANT COLLEGE PROGRAM.
Minnesota Univ., St. Paul. Sea Grant Program.
For primary bibliographic entry see Field 8I.
W90-08986

HYDROLOGIC MODEL FOR MINNESOTA PEATLANDS.
Minnesota Univ., St. Paul. Dept. of Forest Resources.
K. N. Brooks, and D. R. Kreft.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 113-119, Fall 1989. 2 fig, 3 tab, 22 ref.

Descriptors: *Hydrologic models, *Minnesota, *Model studies, *Peat bogs, *Peat soils, *Surface-groundwater relations, *Wetlands, Hydrologic budget, Infiltration, Snowmelt, Storm runoff, Streamflow.

The hydrologic role of peatlands has represented a complex puzzle to hydrologists and resource managers for some time. The role of peatlands in water budgets, groundwater systems, and surface streamflow generation has not been well understood. The Peatland Hydrologic Impact Model (PHIM) is a continuous simulation computer model developed over a twelve-year period to aid hydrologists in understanding the hydrologic functions of peatlands and upland-peatland watersheds. The research has become an iterative process of model design, field work, model refinement, model testing, and additional field work. The model is as physically-based as possible while relying on data input that is readily available to the natural resources community. It simulates streamflow response of peatlands, upland-peatland systems, mined peatlands, and a combination of these watershed units. Hydrologic processes investigated include snow accumulation and snow melt, infiltration using double-ring infiltrometer tests, hydraulic characteristics of peat soils using the point dilution method, flow pathways using water budgets and streamflow studies, and the stormflow response of peatlands. Because a modeling approach was taken initially, the field work was focussed upon collecting the type of information necessary to formulate and calibrate a model. (Tappert-PTT)
W90-08987

HUMAN IMPACTS TO MINNESOTA WETLANDS.
Minnesota Univ.-Duluth. Natural Resources Research Inst.
For primary bibliographic entry see Field 4C.
W90-08988

EXPERIMENTAL-ANALYTICAL METHOD OF MODELLING TRANSFORMATION OF NATURAL ORGANIC MATTER IN WATER STORAGE RESERVOIRS.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
A. Kocharian, V. Gekov, A. Malyutin, and I. Lapin.
Publications of the Water and Environment Research Institute PWEIET, No. 3, p 33-39, 1989. 2 fig, 1 tab, 5 ref.

Descriptors: *Hydraulic models, *Limnology, *Mathematical models, *Model studies, *Organic matter, *Reservoirs, Chemical reactions, Forecasting, Humic substances, Physical models, Residence time, Soviet Union, Uchinsk Reservoir, Water supply.

A method of forecasting the transformation of non-conservative substances based on the substitution of analysis of time of substance residence in a reservoir for particle trajectory analysis is presented. The residence time distribution (RTD) function characterizes the pattern and intensity of water circulation. The value of this function at any given moment is the probability that a flow element, entering the reservoir at the initial moment, will stay in the reservoir during a period shorter than the given time. The RTD function values for different water bodies were obtained experimentally on the basis of physical models. These values permit the calculation of the level of the processes of transformation of non-conservative substances. The method was employed to study the transformation of humic substances in the Uchinsk Reservoir (Soviet Union), which is the source of water supply for Moscow. A good agreement between observed and calculated data was obtained. The present method ensures a considerable simplification of mathematical models describing non-stationary processes of natural organic substance transformation in water storage reservoirs. (Author's abstract)
W90-09030

EXAMINATION OF MODEL ADEQUACY AND ANALYSIS OF PHOSPHORUS DYNAMICS IN LAKE KUORTANEENJARVI: A CASE STUDY WITH TWO LAKE MODELS.
Helsinki Univ. of Technology, Espoo (Finland). Lab. of Hydrology and Water Resources Engineering.
For primary bibliographic entry see Field 5B.
W90-09032

SPECIFIC FEATURES OF WATER DYNAMICS IN DIFFERENT TYPES OF LAKES.
Akademiya Nauk SSSR, Petrozavodsk. Karelskii Filial.
N. Filatov, A. Gurina, Y. Demin, J. Sarkkula, and J. Koponen.
Publications of the Water and Environment Research Institute PWEIET, No. 3, p 55-61, 1989. 5 fig, 3 tab, 4 ref.

Descriptors: *Currents, *Finland, *Hydrodynamics, *Lakes, *Limnology, *Mathematical models, *Model studies, *Network design, *Soviet Union, Lake Krasnoye, Lake Ladoga, Lake Nasijarvi, Morphometry, Velocity fields, Wind.

Three-dimensional mathematical models and results of probabilistic analysis of field measurements were used to study the features of water currents in three lakes of different shape and size (Lake Nasijarvi, Finland, and Lakes Ladoga and Krasnoye, USSR). Observations were used to compute vector current spectra. Typical fluctuations were distinguished in current and temperature spectra. Non-linear diagnostic and prognostic numerical models were used for calculation of currents in Lake Nasijarvi. Qualitatively, the results of calculations of the velocity fields were not controversial and agreed reasonably well with the 30-hr averaged data from the observation stations. For a more correct verification of the models, more observation stations are needed to account for specific circulations of the lake water. The model calculations showed that the amount of observation stations should not be less than 7. Calculations have shown that in the upper 0-5 m layer wind effects prevail, and beneath it the combined effects of baroclinity and bottom relief are observed. (Rochester-PTT)
W90-09033

BIOGEOCHEMISTRY OF IRON IN AN ACIDIC LAKE.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Due-

bendorf (Switzerland).
B. Sulzberger, J. L. Schnoor, R. Giovanoli, J. G. Hering, and J. Zobrist.
Aquatic Sciences AQSCEA, Vol. 52, No. 1, p 56-74, 1990. 9 fig, 47 ref.

Descriptors: *Acid lakes, *Acid rain effects, *Biochemistry, *Geochemistry, *Iron compounds, *Lakes, Chemical precipitation, Chemical reduction, Dissolved solids, Diurnal variation, Lake sediments, Mathematical equations, Minerals, Model studies, Mountain lakes, Oxidation, Photochemistry, Scanning electron microscopy, Switzerland, Water sampling, Weathering.

The fate of iron was monitored in Lake Cristallina, an acidic lake in the Alps of Switzerland. A simple conceptual model was developed in order to explain the observed diel variation in dissolved iron (II) concentration. Biotite weathering provides reduced iron that is oxidized and subsequently precipitated in the lake. The amorphous Fe(III)hydroxide found in the sediments of Lake Cristallina, is an Fe(II) oxidation product. This oxygenation reaction is most probably catalyzed by bacteria surfaces, as indicated by the relatively high estimated oxidation rate compared to the oxidation rate of the homogeneous oxidation of inorganic Fe(II) species at the ambient pH of Lake Cristallina (pH 5.4 at 4 C) and by the scanning electron micrograph pictures. Under the influence of light, these amorphous iron(III) hydroxide phases are reductively dissolved. The net concentration of Fe(II) reflects the balance of the reductive dissolution and the oxidation/precipitation reactions and tends to parallel the light intensity, leading to a diurnal variation in the Fe(II) concentration. The rate of the photochemical reductive dissolution of Lake Cristallina iron(III)hydroxides is greatly enhanced in situ and in the laboratory by addition of oxalate to the lake water. (Author's abstract)
W90-09051

CHANGES IN ACTIVITIES OF INORGANIC CARBON AND AMMONIUM UPTAKE BY PHYTOPLANKTON FROM MAY TO AUGUST, AND THEIR RELATION TO WATER TEMPERATURE IN LAKE NAKANUMA, JAPAN.
Tsukuba Univ. (Japan). Inst. of Biological Sciences.
T. Miyazaki, M. Watase, and K. Miyake.
Japanese Journal of Limnology RIZAAU, Vol. 50, No. 4, p 289-298, October 1990. 7 fig, 3 tab, 31 ref.

Descriptors: *Ammonia, *Bioaccumulation, *Carbon, *Japan, *Lake Nakanuma, *Lakes, *Limnology, *Phytoplankton, *Water temperature, Absorption, Biomass, Chlorophyll a, Light intensity, Nitrogen, Nutrients, Phosphates, Seasonal variation.

Daily and weekly sampling was carried out from May to August in 1986 in Lake Nakanuma to estimate the effects of environmental factors on the uptake of inorganic carbon and ammonium by phytoplankton. Rates of uptake of carbon and ammonium, on the whole, increased during the sampling period, though daily and weekly changes occurred. Among the environmental factors examined, water temperature affected most of the uptake activities. Increased uptake of nutrients in the summer were due mainly to increases in water temperature. Light and nutrients exerted only minor effects on the increases in the uptake activities. The changes in these activities did not correspond to those of chlorophyll a concentration. Active uptake did not necessarily increase phytoplankton biomass. (Author's abstract)
W90-09117

TEMPERATURE STRUCTURE AND VERTICAL MIXING OF WATER MASS IN MESOCOSMS IN LAKE SUWA.
Institute of Physical and Chemical Research, Saitama (Japan).
M. Kishino, M. Takahashi, and H. Hayashi.
Japanese Journal of Limnology RIZAAU, Vol. 50, No. 4, p 299-311, October 1990. 8 fig, 3 tab, 11 ref.
Special Scientific Research of the Ministry of Education, Science and Culture, Japan Nos. 60129034,

61134044, and 62124040.

Descriptors: *Japan, *Lake Suwa, *Lakes, *Limnology, *Mixing, *Thermal stratification, *Water temperature, Advection, Convection, Heat balance, Heat transfer, Turbulent flow, Water circulation, Wind velocity.

Temperature structure was determined in mesocosms of 4.8 m by 48 m by 4.42 m (depth) in Lake Suwa, and the processes affecting the temperature structure, such as heat balance at the surface, heat transfer through the boundary, and turbulence mixing, were evaluated. During daytime the water body was heated by insolation input rather than heat loss of longwave radiation and latent heat, even though it was cooled when insolation input was lower than the loss such as under heavy cloudy and rainy weather. At night, heat loss from the water body prevailed, and convection mixing of the water body occurred. The water column often became isothermal under such conditions. All these processes occurred almost equally both inside and outside the mesocosms. Turbulence of the water body in mesocosms was small during daytime under calm sunny weather, and thermal stratification tended to be formed near the surface. In outside water, turbulence activity disturbed the development of thermal stratification. Turbulence of the water body in mesocosms was mainly created by convection at night and vibration of buoy and wall materials by wind waves. On the other hand, that of outside water was mainly due to wind waves, advection and convection at night. In general, the water body inside and outside the mesocosms in Lake Suwa showed a weak thermal stratification during daytime and mixing throughout the water column at night. The nighttime thorough mixing seems to be important to maintain the productive ecosystem in Lake Suwa as well as in mesocosms. (Author's abstract)
W90-09118

SEASONAL VARIATIONS OF CARBON AND NITROGEN ISOTOPE RATIOS OF PLANKTON AND SINKING PARTICLES IN LAKE KIZAKI.
Mitsubishi-Kasei Inst. of Life Sciences, Tokyo (Japan). Lab. of Biogeochemistry and Sociogeochemistry.
T. Yoshioka, H. Hayashi, and E. Wada.
Japanese Journal of Limnology RIZAAU, Vol. 50, No. 4, p 313-320, October 1990. 2 fig, 2 tab, 25 ref.
Ministry of Education, Science and Culture, Japan Grants-in-Aid for Special Project Research No. 60129034 and for Scientific Research No. 61035027.

Descriptors: *Carbon, *Japan, *Lake Kizaki, *Lakes, *Limnology, *Nitrogen, *Particulate matter, *Plankton, Bottom sediments, Isotopes, Lake sediments, Light intensity, Nutrients, Seasonal variation, Water temperature, Zooplankton.

Seasonal variations in carbon and nitrogen isotope ratios of plankton and sinking particles in Lake Kizaki were observed from April to November 1985 and may to October 1986. Carbon isotope ratio of plankton with the size of 58 to 100 microns, which was mostly composed of phytoplankton, showed the highest value in June (-19 to-15 parts per thousand) and the lowest value in April (-35.3 parts per thousand). The carbon isotope ratio value of plankton larger than 100 microns (mainly zooplankton) was lower by 1 to 5 parts per thousand than those of 58-100 micron plankton. The nitrogen isotope ratios of phytoplankton samples ranged from 1 to 6 parts per thousand and those of zooplankton samples were from 5 to 10 parts per thousand. These changes in carbon and nitrogen isotope ratios of plankton in Lake Kizaki seemed to reflect the growth conditions of phytoplankton, such as water temperature, nutrient concentration, and light intensity. It was also suggested that the relative contributions of NH4(+) and NO3(-) uptakes to total nitrogen uptake might affect the nitrogen isotope ratio of phytoplankton. The seasonal change in carbon isotope ratios of sinking particles collected by sediment trap was not so large, compared with that of phytoplankton. This indicated that the decomposition of autochthonous organic carbon occurred actively in the water

column and that the contribution of allochthonous organic carbon to the bottom sediment was relatively large in Lake Kizaki. (Author's abstract)
W90-09119

CONTINUOUS CURRENT MEASUREMENTS IN LAKE BIWA: II. TIME VARIATIONS OF LAKE CURRENTS IN THE NORTHERN BASIN.
Shiga Univ., Otsu (Japan). Dept. of Earth Science.
S. Endoh, and Y. Okumura.
Japanese Journal of Limnology RIZAAU, Vol. 50, No. 4, p 341-350, October 1990. 10 fig, 2 tab, 17 ref. English summary.

Descriptors: *Coastal waters, *Japan, *Lake Biwa, *Lakes, *Limnology, *Water circulation, *Water currents, *Wind-driven currents, Bottom currents, Hypolimnion, Temporal distribution, Thermal stratification, Thermocline.

Continuous current measurements by using current meters have revealed some characteristics of water currents in the northern basin of Lake Biwa, Japan. The fundamental mode of the internal wave has a great influence on the current field of the offshore zone as well as the coastal zone. The water movement in the hypolimnion is strongly controlled by the internal waves. The internal Poincare wave is dominant in the offshore zone during the period of thermal stratification. Its period, which depends on the internal radius of deformation, is about 17 hr in May and 12 hr in August. Inertial oscillation is also dominant in the thermocline zone, and frequently occurs in the thermocline depth. The cyclonic gyre is disturbed by the effects of continuous strong wind, i.e., the wind driven current and the internal waves. After the wind falls, however, the gyre is soon restored to the original state. Under the strong wind with the direction perpendicular to the shore line, coastal bottom water is transported offshore. (Author's abstract)
W90-09121

CLASSIFICATION OF LAKE BASINS AND LACUSTRINE DEPOSITS OF ESTONIA.
Akademiya Nauk Estonskoi SSR, Tallinn. Inst. Geologii.
L. Saarse.
Journal of Paleolimnology JOUPE8, Vol. 3, No. 1, p 1-12, 1990. 3 fig, 2 tab, 38 ref.

Descriptors: *Estonia, *Lake basins, *Lake classification, *Lake sediments, *Limnology, *Paleolimnology, *Sedimentation, Glacial lakes, Lacustrine environment, Peat bogs, Sedimentology.

Based on extensive data from a long-term investigation, a new genetic classification of lake basins is proposed for Estonia. Eight lake groups are distinguished, tectonic-denudation, glacial, chemical, fluvial, coastal (neotectonic), telmatogenic, cosmogenic and artificial, containing 13 subgroups and 19 basin types. Also proposed is a new lithological classification of Estonia's organic and calcareous lake sediments, based on analyses of more than 2000 sediment samples from 90 contemporary and 50 late-glacial (extinct) lakes. Of the approximately 1,150 Estonian lake basins that formed on mineral substrate, the two largest basins are of preglacial, tectonic-denudation origin, later modified by glaciers. Eight hundred lakes are of glacial origin, and 300 of other origins in the Holocene. In addition, approximately 20,000 bog pools formed on peat in the Holocene. Only minerogenous sedimentation occurred in the lakes in the late-glacial period. After that, organic (gyttjas) and/or calcareous sediments have formed. Azonal factors have been largely responsible for the wide variation in Estonia's lacustrine deposits. (Author's abstract)
W90-09124

PALEOLIMNOLOGY OF MCNEARNEY LAKE: AN ACIDIC LAKE IN NORTHERN MICHIGAN.
Oak Ridge National Lab., TN. Environmental Sciences Div.
R. B. Cook, R. G. Kreis, J. C. Kingston, K. E. Camburn, and S. A. Norton.

Journal of Paleolimnology JOUPE8, Vol. 3, No. 1, p 13-34, 1990. 8 fig, 1 tab, 94 ref. Department of Energy Contract DE-AC05-84OR21400.

Descriptors: *Acid lakes, *Acid rain, *Lake sediments, *Oligotrophic lakes, *Paleolimnology, *Sediment analysis, Acidic water, Aluminum, Diatoms, Hydrogen ion concentration, Lake McNearney, Michigan, Sulfates, Trace metals.

An study was carried out on McNearney Lake, a naturally acidic oligotrophic lake in northern Michigan. The study employed Pb210-dated sediment cores to examine diatom assemblages that reflect the acid-base chemistry of lake water, elements that reflect changes in watershed inputs, and compounds that reflect changes in atmospheric deposition. Predicted pH values ranged from 4.7 to 5.0 over the 4000-yr stratigraphy. Considerable shifts in species composition and abundance were observed in diatom stratigraphy, but present-day distributions indicate that all abundant taxa most frequently occur under acidic conditions, suggesting that factors other than pH are responsible for the shifts. The diatom-inferred pH technique as applied to McNearney Lake has too large an uncertainty and is not sensitive enough to determine the subtle recent changes in lakewater pH expected from changes in atmospheric deposition because: (1) McNearney Lake has the lowest pH in the contemporary diatom data set in the region and confidence intervals for pH predictions increase at the extremes of regressions; (2) other factors in addition to pH may be responsible for the diatom species distribution in the lake and in the entire northern Great Lakes region; (3) McNearney Lake has a well-buffered pH as a consequence of its low pH and high aluminum concentrations and is not expected to exhibit a large ph change as a result of changes in atmospheric deposition; and (4) atmospheric deposition in the region is modest and would not cause a pH shift large enough to be discernable in McNearney Lake. Elevated atmospheric deposition is indicated in recent sediments by Pb, V, and polycyclic aromatic hydrocarbon accumulation rates and to a lesser extent by those of Cu and Zn; however, these accumulation rates are substantially lower than those observed for acidified lakes in the northeastern United States. Although atmospheric loadings of materials associated with fossil fuel combustion have recently increased to McNearney Lake, the study of the diatom subfossil record does not indicate a distinct, recent acidification (pH decrease). (Author's abstract)
W90-09125

AQUATIC MACROPHYTES AND THE PHYSICAL CHEMICAL CONDITIONS OF THE 'ALAGADOS', 'CORIXOS' AND RIVERS IN THE TRANSPANTANEIRA ROAD, PANTANAL MATOGROSSENSE (POCONE, MT) (MACROFITAS AQUATICAS E AS CONDICOES FISICAS E QUIMICAS DOS 'ALAGADOS', 'CORIXOS' E RIOS, AO LONGO DA RODOVIA TRANSPANTANEIRA, PANTANAL MATOGROSSENSE (POCONE-MT)).
Universidade Federal de Mato Grosso, Cuiaba (Brazil). Dept. de Biologia.
C. J. Da Silva, and V. Pinto-Silva.
Revista Brasileira de Biologia RBBIAL, Vol. 49, No. 3, p 691-697, August 1989. 1 fig, 9 tab, 14 ref. English summary.

Descriptors: *Brazil, *Lakes, *Limnology, *Macrophytes, *Physicochemical properties, Air temperature, Chlorophyll a, Dissolved oxygen, Hydrogen ion concentration, Species diversity, Transparency, Water hyacinth, Water temperature.

The composition of aquatic macrophytes and several limnologic parameters were determined in nine different stations in the Transpantaneira Road-Pantanal Matogrossense, Pocone, MT from May, 1981 to June 1982. Air and water temperature, transparency, pH, dissolved oxygen, and chlorophyll a were determined by methods following the IBP recommendations. Results showed air temperature between 21-34.5 C, water temperature between 22-36 C, pH from 3.4 to 9.0, dissolved oxygen from 7 to 143%, chlorophyll a between 0.74-58 micrograms/L, and transparency from 0.02

to 3.0 m (always reaching the bottom). The 'alagados' presented a wider variety of species and forms of life, with Eichhornia azurea being the most common, followed by E. crassipes and Pontederia lanceolata. (Author's abstract)
W90-09130

EPIPHYTIC ALGAL FLORA FROM A LILY POND, SAO PAULO STATE, BRAZIL: 2. XANTHOPHYCEAE (ALGAS EPIFITAS DO LAGO DAS NINFEAS, SAO PAULO, BRASIL: 2. XANTHOPHYCEAE).
Instituto de Botanica, Sao Paulo (Brazil). Seccao de Ficologia.
D. C. Bicudo.
Revista Brasileira de Biologia RBBIAL, Vol. 49, No. 3, p 851-860, August 1989. 23 fig, 25 ref. English summary.

Descriptors: *Brazil, *Limnology, *Macrophytes, *Phytoplankton, *Ponds, Baseline studies, Epiphytes, Species diversity, Taxonomy, Tropical regions.

A survey was made of the epiphytic Xanthophyceae on phytoplankters and aquatic macrophytes from a lily pond, Sao Paulo State, Brazil. Samplings were carried out monthly, from July 1980 to June 1982, at 4 stations. Ten taxa were identified belonging to the families Characiopsidiaceae, Chlorobotrydaceae, and Chloropediaceae. Descriptions, discussion, and detailed analysis of the materials already cited for Brazil are provided. Two genera, botryochloris and chloropedia, and all ten infrageneric taxa were recorded for the first time in Brazil. (Author's abstract)
W90-09132

SURVEY OF MICROBIAL POPULATIONS IN BURIED-VALLEY AQUIFER SEDIMENTS FROM NORTHEASTERN KANSAS.
NSI Technology Services Corp., Ada, OK.
For primary bibliographic entry see Field 2F.
W90-09137

MECHANISMS CONTROLLING THE CHEMICAL COMPOSITION OF LAKES AND RIVERS: DATA FROM AFRICA.
Michigan Univ., Ann Arbor. Dept. of Biology.
For primary bibliographic entry see Field 2K.
W90-09146

CARBON METABOLISM IN A HUMIC LAKE: POOL SIZES AND CYCLING THROUGH ZOOPLANKTON.
Oslo Univ. (Norway). Dept. of Biology.
D. O. Hessen, T. Andersen, and A. Lyche.
Limnology and Oceanography LIOCAH, Vol. 35, No. 1, p 84-99, January 1990. 9 fig, 2 tab, 49 ref.

Descriptors: *Cycling nutrients, *Food chains, *Limnology, *Metabolism, *Organic carbon, *Phytoplankton, *Zooplankton, Aquatic bacteria, Detritus, Humic substances, Lakes, Nutrients, Particulate matter, Radioactive tracers, Respiration.

To characterize the major carbon pathways in a humic lake, the carbon pool sizes and main pathways by long-term tracer studies in enclosures were determined. Dissolved organic carbon was by far the largest pool and constituted 80-85% of total carbon. In the water column particulate organic carbon was partitioned between detritus, zooplankton, bacteria, and phytoplankton at ratios of 22:4:3:1. Phytoplankton and bacterioplankton production averaged 24 and 32 micrograms C/L/day, while crustacean zooplankton production was very low (<5 micrograms C/L/day) during the experiment. Total pelagic community respiration was high, giving a net CO_2 flux to the atmosphere of 44 micrograms C/L/day, while losses by sedimentation were negligible. Most of the particulate carbon available for zooplankton was highly recycled detritus of low nutritional value. The loop of ingestion and defecation of detrital particles was a major carbon pathway, giving detrital particles a turnover rate of 0.39/day. Detritus was found to support 46-82% of body carbon in the surveyed species, with Acanthodiaptomus as the upper ex-

treme. Bacterial carbon accounted for 11-42% of body carbon and phytoplankton for 6-19% in the surveyed species. (Author's abstract)
W90-09147

APPARATUS TO DETERMINE THE EFFICIENCY OF TRANSFER OF BACTERIA FROM A BURSTING BUBBLE TO THE JET DROPS.
State Univ. of New York at Albany. Atmospheric Sciences Research Center.
For primary bibliographic entry see Field 5B.
W90-09148

EMPIRICAL EQUATIONS RELATING SCALAR IRRADIANCE TO A, B/A, AND SOLAR ZENITH ANGLE.
Rochester Univ., NY. Dept. of Biology.
T. T. Bannister.
Limnology and Oceanography LIOCAH, Vol. 35, No. 1, p 173-177, January 1990. 1 fig, 1 tab, 5 ref.

Descriptors: *Irradiation, *Limnology, *Monte Carlo method, *Phytoplankton, Chlorophyll, Lakes, Light penetration, Mathematical models, Water depth.

Equations were derived from Monte Carlo calculations to predict underwater scalar irradiance as a function of depth, solar irradiance, and zenith angle at the surface, and absorption coefficient and ratio of scattering to absorption coefficients in the water. For calculations, the term a was always 0.2/m, b/a was 0, 1, 2 or 4, and zenith angles were 0, 30, 45, 60, and 90 degrees. For downwelling and upwelling cases, quanta and reciprocals of the cosines of zenith angles were summed at depths of 0-60 m by 1-m increments. The equations corrected for the depth dependence of the attenuation coefficient near the surface, and they predicted scalar irradiance to within an error of <10%. The present calculations suggest that Monte Carlo calculations should be extended to greater depths and to higher values of b/a, and perhaps to cases of two or more layers of phytoplankton having different properties. (Geiger-PTT)
W90-09149

PHYTOPLANKTON ABUNDANCE IN FLORIDA LAKES: EVIDENCE FOR THE FREQUENT LACK OF NUTRIENT LIMITATION.
Florida Univ., Gainesville. Dept. of Fisheries and Aquaculture.
S. Agusti, C. M. Duarte, and D. E. Canfield.
Limnology and Oceanography LIOCAH, Vol. 35, No. 1, p 181-188, January 1990. 5 fig, 1 tab, 41 ref. Department of the Interior Project 14-16-0009-79-064.

Descriptors: *Florida, *Lakes, *Limnology, *Phytoplankton, Algae, Aquatic bacteria, Biomass, Chlorophyll a, Chlorophyta, Diatoms, Nutrients, Population density.

A survey of the phytoplankton communities in 165 Florida lakes during 1980 indicated 27% of 308 samples collected had phytoplankton populations that were at or very close to their maximal achievable densities. This finding suggests that nonnutrient constraints including self-regulation by the algal community may be playing an important role in regulating phytoplankton biomass in many Florida lakes. Algal populations that were close to their maximal achievable densities had algal biomass values > 10 mg/L and chlorophyll a concentrations > 10 mg/cu m. As nonnutrient constraints became more important, algal communities shifted from small-celled, diatom-green algal communities to communities dominated primarily by large, blue-green bacteria. (Author's abstract)
W90-09150

CHANGES IN MYSIS AND PONTOPOREIA POPULATIONS IN SOUTHEASTERN LAKE MICHIGAN: A RESPONSE TO SHIFTS IN THE FISH COMMUNITY.
Wisconsin Univ.-Madison. Center for Limnology.
M. E. McDonald, L. B. Crowder, and S. B. Brandt.

Limnology and Oceanography LIOCAH, Vol. 35, No. 1, p 220-227, January 1990. 6 fig, 29 ref.

Descriptors: *Alewife, *Benthos, *Lake Michigan, *Limnology, *Predation, Food chains, Population density, Population dynamics, Spatial distribution.

The abundance and body length of Mysis in 1977, a year of low benthivore (alewife) abundance, was compared to those of 1984-1985, years of high benthivore abundance. Pontoporeia abundance and body length between low benthivore years (1979, 1980) and high benthivore years (1984, 1985) were also compared. Mysis densities between 20 and 50 m did not differ significantly among years, but their densities offshore (80-100 m) declined from 313 sq m in 1977 to 59 sq m in 1985. Mysis mean size did not differ significantly during this time, but there were changes in the length-frequency distribution. Mean Pontoporeia densities declined more than twofold between 1980 and 1984-1985. Pontoporeia mean size was unchanged during this time, but there were changes in the length-frequency distribution. The shifts in these macrobenthic species coincided with shifts in the fish community, suggesting a link to changes in predation rates on the benthos. (Author's abstract)
W90-09152

OVERLAND FLOW IN WETLANDS: VEGETATION RESISTANCE.
Michigan Univ., Ann Arbor. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 2E.
W90-09191

TEMPERATURE EFFECTS ON SILICON AND PHOSPHORUS LIMITED GROWTH AND COMPETITIVE INTERACTIONS AMONG THREE DIATOMS.
Amsterdam Univ. (Netherlands). Dept. of Aquatic Ecology.
E. van Donk, and S. S. Kilham.
Journal of Phycology JPYLAJ, Vol. 26, No. 1, p 40-50, March 1990. 7 fig, 7 tab, 49 ref.

Descriptors: *Diatoms, *Lakes, *Limiting nutrients, *Limnology, *Phosphorus, *Phytoplankton, *Silicon, *Temperature effects, Asterionella, Fragilaria, Growth rates, Lake Maarsseveen, Nutrients, Population dynamics, Stephanodiscus, The Netherlands.

Three diatom species, Stephanodiscus hantzschii (Ehr.) Grun., Asterionella formosa Hass., and Fragilaria crotonensis Kitt. Hass. were isolated from Lake Maarsseveen, the Netherlands, to study the effects of temperature (5 to 20 C) and limitation of Si and P in short-term batch cultures. S. hantzschii had higher maximum growth rates than the other two species at all temperatures. The maximum growth rates of all species increased with increasing temperature. Temperature also affected half-saturation constants (Ks) and the minimum cell quotas. S. hantzschii had low silicon requirements for growth under Si-limiting conditions, and A. formosa and F. crotonensis had higher and nearly identical Si requirements. The Ks values for silicon for S. hantzschii were essentially constant from 5 to 20 C but varied greatly for the other two species. With respect to P requirements for growth under P limitation, A. formosa had the lowest, F. crotonensis was intermediate, and S. hantzschii had the highest. The Ks values for P were constant over the temperature range for both A. formosa and F. crotonensis and were much higher and variable for S. hantzschii. Nutrient competition experiments were performed in continuous cultures at four temperatures (5, 10, 15, 20 C) and various Si:P ratios. Results were generally, but not always, in agreement with Monod relationships. In cultures with all three species P-limited, A. formosa often dominated, although F. crotonensis was sometimes most abundant. S. hantzschii never dominated at high Si:P ratios. At intermediate Si:P ratios when A. formosa and F. crotonensis were both Si-limited and S. hantzschii was P-limited, all three species coexisted. (Cassar-PTT)
W90-09193

MAHSEER CONSERVATION: PROBLEMS AND PROSPECTS.
Garhwal Univ., Srinagar (India). Dept. of Zoology.
P. Nautiyal.
Journal of the Bombay Natural History Society JBOMAA, Vol. 86, No. 1, p 32-36, April 1989. 2 tab, 23 ref.

Descriptors: *Conservation, *Ecological effects, *Endangered species, *Environmental effects, *Fish, *Fish management, *Stream fisheries, *Streams, Alaknanda River, Aquatic habitats, Fish diets, Fish migration, Fish populations, Fishing, Ganges River, Gravel, Habitats, Himalayan Mountains, India, Mahseer, Migration, Mountain streams, Nayar River, River beds, Spawning.

The decline of the mahseer population in India is related to several types of problems. Natural constraints include human interference with migration patterns, effects of water temperature and current on food supply with resulting growth retardation, pollution of lakes, low fecundity, and a long hatching period (80 hr) and semi-quiescent stage. Created constraints include hydroelectric projects, explosives and chemicals use, and overfishing. A few isolated breeding programs have been attempted, with little success. Proposed conservation measures involve measures to promote earlier maturity of the fish (lotic and lentic environments appear most suitable), regulated fishing seasons, and breeding-stocking programs. (Cassar-PTT)
W90-09195

DEVELOPING A PLAN TO MANAGE LAKE VEGETATION.
Wisconsin Geological and Natural History Survey, Madison.
For primary bibliographic entry see Field 5G.
W90-09202

10,000-YR HISTORY OF NATURAL ECOSYSTEM ACIDIFICATION.
Minnesota Univ., Minneapolis. Dept. of Ecology and Behavioral Biology.
M. S. Ford.
Ecological Monographs ECMOAQ, Vol. 60, No. 1, p 57-89, March 1990. 20 ref, 6 tab, 149 ref.

Descriptors: *Acid rain effects, *Acidic lakes, *Diatoms, *Ecosystems, *Lake acidification, *New Hampshire, *Paleoecology, *Paleolimnology, *Sediment chemistry, *Vermont, Aluminum, Data collections, Geochemical analysis, Manganese, Palynology, Pollen.

Long-term acidification processes in New England were studied using paleoecological methods and a paired watershed approach. The primary variable is lithology, and therefore a study was conducted to illuminate the role of lithology in long-term ecosystem acidification. The two sites in the study are similar in size, lake depth, elevation, aspect, and local climate, but Cone Pond, N.H., is an acidic, clearwater lake in a catchment of thin tills derived from base-poor gneisses and schists, whereas South King Pond, VT is a mesotrophic lake in a catchment of thicker tills derived from slates, phyllites, and limestone. Both diatom and geochemical analyses indicated significant long-term acidification of the upland soils and surface waters of Cone Pond, but not the South King Pond, catchment. At Cone Pond, the uplands exported Al almost entirely in labile form by 10,000 yr before present (BP). Increases in labile Al 8000-5500 BP, followed by substantial declines in sedimentary Mn and in the ratio of Ca to organic matter, indicate soil acidification followed by decreasing lakewater pH. The loss of the Melosira/Cyclotella diatom assemblage was approximately 7200 BP as hemlock populations began to expand, coupled with the disappearance of the chrysophyte Mallomonas torquata, suggests increasing lakewater transparency possibly accompanied by decreasing lakewater pH. By 5000 BP, all planktonic diatom species had disappeared and the acidobiontic diatom flora was well established. A sudden decline in the ratio of acid-labile nonbiogenic Si to acid-labile Al also occurred approximately 2000 BP, and appears to reflect dissolution

of an amorphous aluminosilicate complex, providing independent evidence for a precultural pH of approximately 5.0. None of these features are found at South King Pond, where the only paleolimnological evidence of acidification is a sharp decline in sedimentary carbonates of approximately 5000 BP. This decrease, however, appears to be related to climatic factors rather than to lakewater pH. (Author's abstract)
W90-09207

IMPACT OF INTERNAL PHOSPHORUS LOADING ON THE RESTORATION OF TROUT LAKE.
North Dakota Univ., Grand Forks. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5G.
W90-09209

ECOTOXICOLOGY AND ECOSYSTEM INTEGRITY: THE GREAT LAKES EXAMINED.
Wisconsin Univ.-Green Bay.
H. J. Harris, P. E. Sager, H. A. Regier, and G. R. Francis.
Environmental Science and Technology ESTHAG, Vol. 24, No. 5, p 598-603, May 1990. 2 fig, 29 ref.

Descriptors: *Ecological effects, *Ecosystems, *Ecotoxicology, *Environmental impact, *Great Lakes, *Toxicity, *Toxicology, *Water pollution effects, Analytical techniques, Lake restoration, Polychlorinated biphenyls.

Ecotoxicology has emerged as a major research area in response to the problem of environmental contamination with toxic chemicals, particularly chlorinated hydrocarbons. It employs both reductionistic science (toxicology) with strong predictive capabilities and holistic science (ecology) with recognizably weak diagnostic and predictive capabilities. Now that mandates require the restoration and protection of the Great Lakes ecosystems, ecologists and toxicologists (ecotoxicologists) are being challenged along several lines: to develop more sensitive means of measuring the loss (or recovery) of ecosystem integrity; to resolve the problem of extrapolation of data from standard laboratory species to enormously complex ecosystems; and to structure a means of accounting for the true systemic impact of a toxicant, including social and economic costs. Issues of ecotoxicology must be viewed in the context of society. Toxic contaminant problems arise as the cumulative consequences of various polluting activities, and they similarly affect various social groups. Degraded ecosystems, such as Green Bay and other Areas of Concern in the Great Lakes, reflect a historic allocation of resources towards those users and beneficiaries who were not dependent on maintaining high environmental quality or sensitive biota. Ecosystem rehabitation strategies seek a reallocation in favor of the more sensitive beneficial uses and values. Ecotoxicology as a conceptual and practical field of study must focus more attention on ecosystem processes to address fully the societal impact of toxic chemicals in our environment. (Chonka-PTT)
W90-09213

COLLOIDAL BEHAVIOR OF ACTINIDES IN AN OLIGOTROPHIC LAKE.
Argonne National Lab., IL. Environmental Research Div.
For primary bibliographic entry see Field 5B.
W90-09219

MODEL OF THE EXCHANGE OF INORGANIC CHEMICALS BETWEEN WATER AND SEDIMENTS.
Toronto Univ. (Ontario). Inst. for Environmental Studies.
For primary bibliographic entry see Field 5B.
W90-09220

SPATIAL AND TEMPORAL PATTERNS IN STRUCTURE OF MACROBENTHIC ASSEM-

BLAGES. A THREE-YEAR STUDY IN THE NORTHERN ADRIATIC SEA IN FRONT OF THE PO RIVER DELTA.
Ente Nazionale per l'Energia Elettrica, Milan (Italy). Centro Termica e Nucleare.
R. Ambrogi, D. Bedulli, and G. Zurlini.
Marine Ecology (PSZNI) MAECDR, Vol. 11, No. 1, p 25-41, 1st quarter, 1990. 9 fig, 58 ref.

Descriptors: *Adriatic Sea, *Benthic environment, *Benthic fauna, *Coastal waters, *Multivariate analysis, *Po River Delta, *Seasonal distribution, *Spatial distribution, *Statistical analysis, Bottom sampling, Data acquisition, Data interpretation.

Coastal benthic communities in soft-bottom deposits of a restricted area in the Northern Adriatic Sea, in front of the Po River Delta, were studied by seasonal sampling at nine stations. The area is affected by temperature and salinity fluctuations depending on season, on river flow rate, and on tidal cycles. Summer oxygen concentrations near the bottom can be low at the 5 and 8 m depths (minimum 47% of saturation). A rather stable sandy substrate was found at the 2.5 m and 5 m stations; at 8 m a greater variability was found. The temporal and spatial distribution was analyzed by correspondence analysis (102 station-points x 107 taxa). The first axis is interpreted as a complex of factors linked to depth; the second axis is related to the season of sampling. Faunal assemblages at three different depths were consistently different and exhibited a seasonal pattern of abundance and diversity. Multivariate statistical analyses suggest that each community structure is very stable during the three summer samplings; in autumn and winter many causes of disturbance can disrupt this structure, which is reconstituted the following summer. In comparison with some multiannual benthic studies, and bearing in mind the various definitions of stability in relation to disturbance, a cyclic adjustment stability can be used as a model for explaining the dynamics of the benthic communities in this area. The stability of benthic communities in this physically variable environment is discussed and a 'cyclic' adjustment mechanism of stability is proposed to explain the dynamics of the benthos in this area. (Chonka-PTT)
W90-09225

ZONATION AND ECOLOGY OF EPIPHYTIC HYDROIDS IN A MEDITERRANEAN COASTAL LAGOON: THE 'STAGNONE' OF MARSALA (NORTH-WEST SICILY).
Istituto Sperimentale Talassografico 'Attilio Cerruti', Taranto (Italy).
S. Piraino, and C. Morri.
Marine Ecology (PSZNI) MAECDR, Vol. 11, No. 1, p 43-60, 1st quarter, 1990. 8 fig, 56 ref.

Descriptors: *Benthic environment, *Benthos, *Coastal waters, *Distribution patterns, *Lagoons, *Sea grasses, *Sicily, Data collections, Mediterranean, Spatial distribution, Temporal distribution.

Distribution patterns of epiphytic hydroids of seagrass (Posidonia oceanica and Cymodocea nodosa) beds were studied in the 'Stagnone,' a moderately hyperhaline lagoon in Sicily. Two distinct communities of epiphytic hydroids were recognized: one more frequently associated with Cymodocea leaves and one connected with Posidonia. The community associated with Cymodocea shows larger seasonal variations which indicate a mainly stochastic colonization of the biotope. The epiphytic assemblage of Posidonia shows a greater stability, all the component species being well adapted to their biotic substrate. Within both communities, parallel zonations develop along the external-internal gradient. In the outermost areas typical 'marine' species were found; they were replaced by 'lagoonal' species in the inner areas of the basin. Salinity does not seem to be the major factor in hydroid zonation, which on the contrary results from the interaction between substratum type and hydrodynamic gradient. The hydroid response to such a gradient could be detected not only at the synecological level (community zonation), but also at the autoecological level in terms of intraspecific morphological variations such as lengthening of hydrocauli or the loss of anchoring structures and mechanical protection when hydrodynamic stress decreases. (Chonka-PTT)

W90-09226

ECOLOGICAL SIGNIFICANCE OF GRAZING ON PLANKTONIC POPULATIONS OF CYANOBACTERIA BY THE CILIATE NASSULA.
Freshwater Biological Association, Ambleside (England).
H. M. Canter, S. I. Heaney, and J. W. G. Lund.
New Phytologist NEPHAV, Vol. 114, No. 2, p 247-263, February 1990. 9 fig, 39 ref.

Descriptors: *Cyanophyta, *Food chains, *Limnology, *Phytoplankton, *Protozoa, Ecological effects, England, Lake District, Lakes.

The grazing of planktonic cyanobacteria (blue-green algae) by the ciliate Nassula aurea Ehr (N. aurea) was observed in three lakes in the English Lake District, Cumbria. Substantial declines in blooms of Aphanizomenon flos-aquae due to feeding by N. aurea were found from Esthwaite Water and Blelham Tarn. The development of appreciable populations of Nassula is clearly dependent upon the presence of sufficient and suitable food in the plankton. Cyanobacteria are generally considered to be summer dominants, but for Aphanizomenon in Esthwaite Water and Blelham Tarn from 1986-1988 there is considerable interannual variability of periodicity within each lake and between lakes within years. (Chonka-PTT)
W90-09228

EXPERIMENTAL MESOCOSM STUDY OF THE SEPARATE AND INTERACTION EFFECTS OF PHOSPHORUS AND MOSQUITO-FISH (GAMBUSIA AFFINIS) ON PLANKTON COMMUNITY STRUCTURE.
Texas Christian Univ., Fort Worth. Dept. of Biology.
H. F. Lancaster, and R. W. Drenner.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 3, p 471-479, 1990. 6 fig, 2 tab, 30 ref. NSF grant BSR 84-15619.

Descriptors: *Algae, *Fish populations, *Gambusia, *Limnology, *Nutrients, *Phosphorus, *Plankton, *Population dynamics, *Zooplankton, Chironomids, Chlorophyll, Chlorophyta, Chrysophytes, Cladocerans, Cryptomonads, Cyanophyta, Diatoms, Dinoflagellates, Nitrogen, Secchi depth.

Community impacts of phosphorus and mosquito-fish (Gambusia affinis) were studied in an experimental mesocosm study of factorial design in which two levels of phosphorus addition were cross-classified with two levels of fish. Total phosphorus, chlorophyll, cryptomonads, unicellular green algae, unicellular blue-green algae, colonial blue-green algae, filamentous blue-green algae, chironomid tube length, cladocerans, fish density, and fish biomass were significantly enhanced in the presence of phosphorus addition. Total nitrogen, total nitrogen:total phosphorus ratio, Secchi depth, chrysophytes, and periphytic diatoms were suppressed in the presence of phosphorus addition. Diatoms, filamentous blue-green algae, chrysophytes, periphytic unicellular and colonial green algae, periphytic filamentous blue-green algae, and rotifers were enhanced in the presence of mosquitofish. Secchi depth, total nitrogen:total phosphorus ratio, cyclopoid copepods, nauplii, cladocerans, and chironomid tubes were suppressed in the presence of mosquito fish. Significant phosphorus x mosquitofish interaction effects were found for total nitrogen:total phosphorus ratio, chrysophytes, dinoflagellates, periphytic colonial green algae, cladocerans, and chironomid tubes. These results show that nutrients and fish do not act as independent regulators of plankton communities but instead have effects which can only be predicted from an understanding of their combined impacts. (Author's abstract)
W90-09232

LAKE DYNAMICS AND THE EFFECTS OF FLOODING ON TOTAL PHOSPHORUS.
National Hydrology Research Inst., Saskatoon (Saskatchewan).
B. C. Kenney.
Canadian Journal of Fisheries and Aquatic Sci-

ences CJFSDX, Vol. 47, No. 3, p 480-485, 1990. 5 fig, 8 ref.

Descriptors: *Eutrophication, *Floodwater, *Lake Washington, *Lakes, *Phosphorus, *Urban runoff, *Washington, *Water pollution control, Fluctuations, Lake sedimentation, Sedimentation, Simulation, Water chemistry, Water circulation, Water pollution.

The concentration of total phosphorus in Lake Washington before and after the sewage diversion project was simulated using first-order linear dynamics. Fluctuation in total phosphorus in the lake occurred as a forced response to changes in inflow phosphorus concentration. The dynamics of total phosphorus in Lake Washington was adequately represented by two independent time scales based on water renewal and sedimentation. The water renewal time scale was modeled as a time dependent process. Sedimentation of total phosphorus, on the other hand, appeared constant over the 16-year period that data were available. A marked increase of total phosphorus in the lake occurred during two flood periods when high concentrations of total phosphorus corresponded to small values of the water renewal time scale (i.e., high flows). At other times, peak concentrations of total phosphorus in the inflow coincided with large values of the water renewal time scale and the lake was dynamically unable to respond to these peaks. (Author's abstract)
W90-09233

PLANT PIGMENTS AS TRACERS OF EMERGENT AND SUBMERGENT MACROPHYTES FROM THE HUDSON RIVER.
New York Botanical Garden, Bronx, NY. Inst. of Ecosystem Studies.
For primary bibliographic entry see Field 7B.
W90-09234

FILTERING RATES OF DIAPTOMUS MINUTUS, BOSMINA SPP., DIAPHANOSOMA SP., HOLOPEDIUM GIBBERUM (CRUSTACEA), AND ZOOPLANKTON COMMUNITY GRAZING RATES IN SOME ACIDIC AND CIRCUMNEUTRAL ONTARIO LAKES.
Toronto Univ. (Ontario). Inst. for Environmental Studies.
A. H. Bleiwas, and P. M. Stokes.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 3, p 495-504, 1990. 3 fig, 3 tab, 53 ref.

Descriptors: *Acid lakes, *Acid rain effects, *Acidic water, *Canada, *Grazing, *Ontario, *Zooplankton, Alkalinity, Biomass, Bosmina, Chlorophyll a, Diaphanosoma, Diaptomus, Holopedium, Hydrogen ion concentration, Light intensity, Plankton, Water temperature.

Filtering rates of several zooplankters and grazing rates of the zooplankton community were investigated in seven Ontario lakes ranging in mean pH from 4.6 to 7.1. Filtering rates of Diaptomus minutus, Diaphanosoma sp., and Holopedium gibberum were negatively correlated with lake pH and alkalinity; rates for these species averaged 89 microliters/individual/hour for Diaptomus minutus, 171 microliters/individual/hour for Diaphanosoma sp., and 514 microliters/individual/hour for Holopedium gibberum in circumneutral lakes and 200, 374, and 1853 microliters/individual/hour in acidic lakes. The filtering rate of Bosmina spp. was not correlated with lake pH; its average rates were 35 microliters/individual/hour in circumneutral lakes and 44 microliters/individual/hour in acidic lakes. Other environmental parameters examined (temperature, light intensity, plankton biomass, chlorophyll a concentration) did not appear to influence the filtering rate of most species tested. Zooplankton community grazing rates were not correlated with lake pH; rates averaged 1.1%/hour in circumneutral lakes, and 1.5%/hour in acidic lakes. This result does not support a previous hypothesis that the efficiency of energy transfer from primary to secondary trophic levels is reduced by acidification. There was no indication that grazing pressure on small versus large cells changed at low pH,

based on comparisons of community grazing rates on the small alga Chlorella and the larger Cosmarium. (Author's abstract)
W90-09235

TRANSPORT AND STORAGE OF 137CS AND 210PB IN SEDIMENTS OF LAKE ST. CLAIR.
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 5B.
W90-09237

STORAGE AND DYNAMICS OF SUBSURFACE DETRITUS IN A SAND-BOTTOMED STREAM.
Virginia Commonwealth Univ., Richmond. Dept. of Biology.
G. M. Metzler, and L. A. Smock.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 3, p 588-594, 1990. 4 fig, 3 tab, 28 ref. NSF grants BSR-8315763 and BSR-8614828.

Descriptors: *Bottom sediments, *Decomposing organic matter, *Detritus, *Sedimentation, *Streambeds, Carbon cycle, Leaves, Organic carbon, Sediment analysis, Streams, Virginia, Wood.

Annual mean storage of buried detritus (0-20 cm depth) in a first-order, sand-bottomed stream was 4.8 kg ash free dry mass/square m, approximately one order of magnitude greater than surface storage. The study was conducted in Buzzards Branch, a blackwater stream in Surrey County, Virginia. Forty percent of the buried detritus was wood > 8 mm; much of the remainder was 1-8 mm particles. Exchange of detritus between surface and shallow sediments occurred throughout the year; exchange between surface and deep sediments occurred only during spates. Heavy rainfall during a September hurricane caused a mean scour depth of 6 cm (range of 0-27 cm) and contributed to a 0.94 kg/square m reduction of buried detritus. Buried leaves were processed slower than leaves on the sediment surface (25% of initial buried leaves remained after 1 year). Particles < 8mm were processed faster from January to March (19% mass reduction) than at other times (8-9% mass reduction). Except during the September spate, burial was approximately offset by decomposition. About 21% of estimated autumnal leaf input to the stream became buried. Given the large quantity of detritus stored in the subsurface, its slow processing rate and the episodic nature of its release from deep storage, the hyporheic area of this stream has an important effect on the stream's carbon spiralling length, energetics, and trophic dynamics. The hyporheic zone is an important component of organic matter dynamics in Buzzards Branch. Sediment instability in terms of both scour and deposition, is a key factor affecting storage, processing, and transport of buried detritus through its effect on burial and release of detritus and the chemical environment (particularly dissolved oxygen). High spatial and temporal variability in sediment movement resulted in highly variable detritus storage and movement in the channel. Hyporheic invertebrates are affected by this variability. (Mertz-PTT)
W90-09238

EVALUATION OF THE EFFECTS OF ATMOSPHERIC ACIDIC DEPOSITION ON FISH AND THE FISHERY RESOURCE OF CANADA.
Department of Fisheries and Oceans, Sault Ste. Marie (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences.
For primary bibliographic entry see Field 5C.
W90-09239

EFFECT OF VARYING WATER PH ON THE ACIDIFICATION OF EXPIRED WATER IN RAINBOW TROUT.
British Columbia Univ., Vancouver. Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W90-09241

SALINITY AND NUTRIENT LIMITATIONS ON GROWTH OF BENTHIC ALGAE FROM TWO ALKALINE SALT LAKES OF THE WESTERN GREAT BASIN (USA).
Sierra Nevada Aquatic Research Lab., Mammoth Lakes, CA.
D. B. Herbst, and T. J. Bradley.
Journal of Phycology JPYLAJ, Vol. 25, No. 4, p 673-678, December 1989. 4 fig, 27 ref. NSF grant DCB-8608664.

Descriptors: *Algae, *Algal growth, *California, *Lakes, *Limiting nutrients, *Limnology, *Oregon, *Saline lakes, Ammonium, Benthic algae, Chlorophyta, Cyanophyta, Diatoms, Nitrates, Nitrogen, Nutrients, Organic matter, Pigments, Salinity, Salinity tolerance.

Enrichment cultures of littoral benthic algae from Mono Lake, California, and Abert Lake, Oregon, were grown under conditions of varied salinity and nutrient content. Field-collected inocula were composed mainly of diatoms and filamentous blue-green and green algae. The yield of long-term cultures (30 days) showed tolerance over a broad salinity range (50-150 g/L) for Mono Lake-derived algae. Algae from Abert Lake had a lower range of tolerance (25-100 g/L). Organic content and pigment concentrations of algae from both lakes were also reduced above the tolerated salinity level. Within the range of salinity tolerance from Mono Lake algae, initial growth rates and organic content were reduced by increased salinity. The effects of macronutrient and micronutrient enrichment on algal growth in Mono Lake water were also tested. Only nitrogen enrichment (either as ammonium or nitrate) stimulated algal growth. Although the benthic algae cultured here had wide optima for salinity tolerance, the rates of growth and storage were limited by increased salinity within the optimum range. Although the lakes compared had similar species composition, the range and limits of tolerance of the algae were related to the salinity of the lake or origin. (Author's abstract)
W90-09245

VARIATION IN DIATOM COMMUNITY STRUCTURE AMONG HABITATS IN SANDY STREAMS.
Louisville Univ., KY. Dept. of Biology.
R. J. Stevenson, and S. Hashim.
Journal of Phycology JPYLAJ, Vol. 25, No. 4, p 678-686, December 1989. 7 fig, 4 tab, 42 ref.

Descriptors: *Algae, *Diatoms, *Michigan, *Species composition, *Stream biota, Benthic flora, Eutrophic rivers, Eutrophication, Habitats, Macrophytes, Maple River, Organic matter, Plankton, Rocks, Sand, Streams, Substrates.

Many factors may enhance or limit differences in benthic algal community dynamics among habitats in streams and thereby regulate community structure and function. These factors are important from perspectives of stream ecology and algal evolutionary ecology. Variation in algal dynamics among habitats may result from algal adaptation to direct abiotic and/or biotic pressures resulting from physico-chemical differences among habitats in streams. The East and West Branches of the Maple River in northern Michigan have similar substrata but drain catchments with different land uses and headwater ecosystems. Headwaters of the West Branch of the Maple River are a large wetland and a lake, from which it runs through a catchment with greater agricultural usage than the catchment of the East Branch. The East Branch of the Maple River drains Douglas Lake, which is known to become nitrogen limited during summers. Seventy-six samples were collected from rocks, sand, macrophytes, and the water columns of the East and West Maple Rivers during the summers of 1983 and 1984. Diatoms were scraped from rocks, cores of sand were collected, macrophyte leaves and stems were gathered and whole water samples were taken. Community structure of benthic diatoms in the two sandy streams was studied to assess differences in abundances and species composition among habitats and between years and streams. The greatest differences in abundances were lower abundances on rocks than

on sand, whether the sand was clean or covered with flocculent organic material. Relatively little variation in abundances occurred between years and streams. Species composition of diatom communities varied more among habitats and between streams than from year to year. Species composition was most unique in floc-covered sand when communities in clean and floc-covered sand, rock, plant, and plankton were compared. Diatom species composition in these sandy streams was most similar on sand and rocks. (Mertz-PTT)
W90-09246

AMMONIUM, NITRATE, PHOSPHATE, AND INORGANIC CARBON UPTAKE IN AN OLIGOTROPHIC LAKE: SEASONAL VARIATIONS AMONG LIGHT RESPONSE VARIABLES.
Montana State Univ., Bozeman. Dept. of Biology.
W. K. Dodds, and J. C. Priscu.
Journal of Phycology JPYLAJ, Vol. 25, No. 4, p 699-705, December 1989. 7 fig, 4 tab, 30 ref.

Descriptors: *Algae, *Carbon cycle, *Lakes, *Limnology, *Nutrients, *Oligotrophic lakes, *Photosynthesis, *Radioactive tracers, Algal growth, Ammonium, Carbon dioxide, Montana, Nitrates, Phosphates, Photosynthetic photon flux density, Seasonal variation.

Photosynthetic photon flux density is of importance as a major controlling factor for inorganic C uptake by algae. The dependence of substrate saturated uptake of 15NH4(+), 15NO3(-), 32PO4(3-), and 14CO2 on photosynthetic photon flux density (or photosynthetically active radiation, 400-700 nm) was characterized seasonally in oligotrophic Flathead Lake, Montana. PO4(3-) uptake was not dependent upon photosynthetic photon flux density at any time of the year, whereas NH4(+), NO3(-), and CO2 uptake were consistently dependent on it over all seasons. Maximal rates of NH4(+), NO3(-) and CO2 uptake usually occurred near 40% of surface photosynthetic photon flux density, which corresponded to about 5 m in the lake; inhibition was evident at photosynthetic photon flux density levels greater than 40%. NH4(+), NO3(-) and PO4(3-) were incorporated in the dark at measurable rates most of the year, whereas dark CO2 uptake was always near 0 relative to light uptake. CO2 and NO(3-) uptake were more strongly influenced by photosynthetic photon flux density than was NH4(+) uptake. The photosynthetic photon flux density dependence of PO4(3-), NH4(+), NO3(-) and CO2 uptake may affect algal growth and nutrient status by influencing the balance in diel and seasonal C:N:P uptake ratios. (Mertz-PTT)
W90-09247

EFFECTS OF IMPOUNDMENT ON THE PHYSICOCHEMISTRY OF TWO CONTRASTING SOUTHERN AFRICAN RIVER SYSTEMS.
Rhodes Univ., Grahamstown (South Africa). Inst. of Freshwater Studies.
For primary bibliographic entry see Field 6G.
W90-09248

EFFECTS OF FLUCTUATING LEVELS OF LAKE SUPERIOR ON MORPHOLOGICAL ADJUSTMENTS IN THE NEEBING-MCINTYRE FLOODWAY, THUNDER BAY, ONTARIO, CANADA.
Lakehead Univ., Thunder Bay (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W90-09249

INTERACTIONS BETWEEN GEOMORPHOLOGICAL PROCESSES, BENTHIC AND HYPORHEIC COMMUNITIES: FIRST RESULTS ON A BY-PASSED CANAL OF THE FRENCH UPPER RHONE RIVER.
Lyon-1 Univ., Villeurbanne (France). Lab. d'Hydrobiologie et Ecologie Souterraines.
M. C. des Chatelliers, and J. L. Reygrobellet.
Regulated Rivers Research & Management RRRMEP, Vol. 5, No. 2, p 139-158, March/May 1990. 9 fig, 84 ref, 2 append. Centre National de la

Recherche Scientifique, the French Ministry of Environment and the Commission of European Communities contracts EN693F and ENV880F.

Descriptors: *Channel morphology, *France, *Geomorphology, *Rhone River, *Riffles, *River systems, *Stream biota, *Surface-groundwater relations, Benthic fauna, Canal seepage, Flow velocity, Groundwater, Groundwater movement, Habitats, Organic matter, Oxygen, Sedimentation, Seepage, Water circulation, Water currents.

It is possible to understand the functional structure of the alluvial Rhone valley by taking into account its geomorphology and its three spatial dimensions: longitudinal, transversal, and vertical. An ecological methodology, based on geomorphology and dealing with both benthic and hyporheic layers of the river bed, was tested on the Upper Rhone river near Lyon, France. The methodology allowed the description, by single spatial survey, of a functional profile of the canal incorporating both hydrological and faunistic fluxes. The ecological importance of riffles was emphasized and the results indicated that, even in a disturbed channel, geomorphological processes (such as degradation/aggradation) act as ecological constraints, especially in the hyporheic layers where they determine community structure by influencing groundwater circulation. Analysis of the surface layer showed that the distribution of benthic organisms was mainly affected by a modification of current velocity, which in turn depended on the topographical characteristics of the canal. In the aggraded zone, the canal functioned as a seepage system: on the one hand, there were inputs of organic matter and oxygen into the hyporheic layer; on the other hand, the deep groundwater no longer acted to buffer the environment. This work confirms the relationship between the origin and circulation of the water in the sediments and the distribution of the interstitial fauna in riffles and convex bars. On the scale of these geomorphological units, the distribution of the fauna within the sediments was clearly determined by groundwater flows. The methodology used to study the Rhone proved to be a good tool over different scales for ecological studies of fluvial systems. (Mertz-PTT)
W90-09251

RIPARIAN WOODY PLANT COMMUNITY OF REGULATED RIVERS IN EASTERN ENGLAND.
Essex Univ., Colchester (England). Dept. of Biology.
C. F. Mason, and S. M. MacDonald.
Regulated Rivers Research & Management RRRMEP, Vol. 5, No. 2, p 159-166, March/May 1990. 4 fig, 3 tab, 22 ref.

Descriptors: *England, *Riparian vegetation, *River basins, *Shrubs, *Trees, *Wales, Alder trees, Comparison studies, Population density, River banks, Surveys, Willow trees.

The riparian woody vegetation (trees and shrubs) is described from a survey of 50 one km stretches of rivers in East Anglia, England, between 1985 and 1987. Tree loss along three rivers was estimated from 1879 maps and aerial photographs taken in 1960 and 1970. A total of 48 species of trees and shrubs were recorded, with Alnus glutinosa, Salix alba, and Salix fragilis dominating the overall community. Overall tree density ranged from 0 to 185/km, average 73/km. The majority of stretches had less than 25 mature trees, with less than 10 individuals of any one species. Sites were classified, based on the frequency of occurrence of species, into four groups using TWINSPAN. TWINSPAN arranges sites into hierarchical groups on the basis of their taxonomic composition, while species are simultaneously classified on the basis of their occurrence in site groups. The technique also identifies indicator species. Marked decreases in densities of riparian trees were apparent over the period 1879-1970, averaging 8% per annum on the river with the greatest initial starting densities. Tree densities, counted from the aerial photographs of 1970, ranged from 25-35/km. The results from East Anglia are compared with a similar study from a less intensively managed region in western Britain (Wales). In Wales 60% of stretches had more than

80 trees/km, compared with only 12% in East Anglia. Some 12% of stretches in Wales had more than 160 mature trees/km, but no sites in East Anglia did. This emphasizes the much greater level of management applied to East Anglian rivers compared with those in the west of the country, with mature trees having been felled and saplings being cleared before they mature. (Mertz-PTT)
W90-09252

SAMPLER FOR INTERSTITIAL FAUNA IN ALLUVIAL RIVERS.
Centre National de la Recherche Scientifique, Toulouse (France). Centre d'Ecologie des Ressources Renouvelables.
For primary bibliographic entry see Field 7B.
W90-09254

DENITRIFICATION AND DINITROGEN FIXATION IN TWO QUAKING FENS IN THE VECHTPLASSEN AREA, THE NETHERLANDS.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Plant Ecology.
W. Koerselman, H. De Caluwe, and W. M. Kieskamp.
Biogeochemistry BIOGEP, Vol. 8, No. 2, p 153-165, September 1989. 2 fig, 1 tab, 38 ref.

Descriptors: *Acetylene reduction, *Denitrification, *Fens, *Limnology, *Nitrogen fixation, *The Netherlands, *Wetlands, Alder trees, Muck soils, Nitrogen cycle, Peat bogs, Peat soils, Precipitation, Soil analysis, Sphagnum.

Laboratory experiments on dinitrogen fixation and denitrification for two (a discharge fen and a recharge fen) using the acetylene reduction assay and the acetylene inhibition technique, respectively, are reported. Nitrogenase activity was detected in peat muck and associated with Alnus glutinosa saplings throughout the study period (May-October 1987), whereas no activity was observed associated with Sphagnum species. The annual amount of dinitrogen fixed was estimated at 2.1 and 12.7 kg N/ha/y for the recharge fen and the discharge fen, respectively. Denitrification at ambient nitrate levels (0.1ppm NO(3)) was absent in the discharge fen and very low in the recharge fen (0.1 microg N/d, or 0.3 kg N/ha/y). In nitrate-amended soil samples denitrification rates were 2 to 3 orders of magnitude higher. In situ denitrification rates in the fens studied seem to depend almost entirely on the nitrate supplied by precipitation. Denitrification rates associated with precipitation are estimated at 1.1 kg N/ha/y for both fens. (Author's abstract)
W90-09267

IMPACT OF DELTAMETHRIN INSECTICIDE ON CHIRONOMIDEA (DIPTERA) OF PRAIRIE PONDS.
Saskatchewan Univ., Saskatoon. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W90-09290

MICROPHYTOBENTHIC PIGMENTS IN A SALT MARSH POND DETERMINED BY HPLC AND SPECTROPHOTOMETRY.
IFREMER, Paris (France).
For primary bibliographic entry see Field 7B.
W90-09294

EFFECT OF CELLULAR CARBOHYDRATE CONTENT AND NUTRIENT STATUS ON THE RESPIRATORY OXYGEN UPTAKE RATE OF A MICROCYSTIS POPULATION IN A EUTROPHIC POND.
Tokyo Metropolitan Univ. (Japan). Dept. of Biology.
Y. Watanabe, and F. Kimura.
Marine Microbial Food Webs, Vol. 4, No. 1, p 129-138, 1990. 6 fig, 1 tab, 15 ref.

Descriptors: *Algal blooms, *Cyanophyta, *Eutrophic lakes, *Limnology, *Microcystis, *Oxygen uptake, *Ponds, *Respiration, Ammonium, Carbohydrates, Eutrophication, Nitrogen, Nutrient requirements, Water pollution effects.

The respiratory oxygen uptake in the dark of a cyanobacterial population, Microcystis species, that formed a dense bloom in a eutrophic pond, was examined. The respiration rate was dependent on the incubation time in the dark, the light history and physiological conditions of the cells. The rate corresponded to the amount of carbohydrate accumulated in the cells during the light period. When the Microcystis population was incubated in a nutrient rich medium under a light-dark cycle in the laboratory, the carbohydrate content increased in the light and decreased in the dark, and the respiration rate was positively correlated with the content. The population in the pond, however, exhibited a different diel pattern of respiration. It did not decrease or sometimes increased during the night, irrespective of the decrease in carbohydrate content. This appeared to be due to nitrogen depletion in the evening and recovery from it during the night. Stimulation of the respiration rate was demonstrated by ammonium enrichment to N-deficient cells in the pond water in which dissolved inorganic nitrogen was exhausted. (Author's abstract)
W90-09295

TOXIC EFFECTS OF SALINITY (S PPT) ON SOME FRESHWATER FISHES (IN CHINESE).
For primary bibliographic entry see Field 5C.
W90-09330

RATIONALE FOR OHIO'S DETERGENT PHOSPHORUS BAN.
International Joint Commission-United States and Canada, Windsor (Ontario). Great Lakes Regional Office.
For primary bibliographic entry see Field 5G.
W90-09343

EFFECTS OF ARTIFICIAL CIRCULATION ON HYPEREUTROPHIC LAKE.
Metropolitan Council, St. Paul, MN.
For primary bibliographic entry see Field 5G.
W90-09344

REELFOOT LAKE SEDIMENTATION RATES AND SOURCES.
Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.
For primary bibliographic entry see Field 2J.
W90-09346

SATURATION-BASED MODEL OF RELATIVE WETNESS FOR WETLAND IDENTIFICATION.
East Carolina Univ., Greenville, NC. Dept. of Geography and Planning.
J. D. Phillips.
Water Resources Bulletin WARBAQ, Vol. 26, No. 2, p 333-342, April 1990. 2 fig, 4 tab, 20 ref.

Descriptors: *Mapping, *Model studies, *Saturation, *Wetlands, *Wetness, Geographic information systems.

A wetness index that was derived from Beven's distributed hillslope runoff model and based on the concept of relative wetness has been introduced as a wetland identification and mapping tool. Data requirements were modified to make the model suitable for use by managers and field agents. The model predicts the relative propensity of any point or small area within a landscape unit to become saturated. This allows an index of relative wetness to be produced. Points on the landscape can then be assigned values of relative wetness. The index has potential utility for (1) providing more detailed information on wetness conditions than binary (wetland-nonwetland) classification systems now in use; (2) assisting in wetland identification when field indicators are absent or ambiguous; (3) application in dryland environments where common wetland indicators are largely irrelevant; and (4) broad-scale wetland mapping in a geographic information systems environment using existing digital topographic and soils databases. A test of the wetness index along a transect across a coastal plain drainage basin showed that the index values agree well with pedologic indicators of wetland

conditions, but provides a far more precise means of determining relative wetness. (Peters-PTT)
W90-09357

USE OF AN ECOSYSTEM APPROACH TO RE-STORE DEGRADED AREAS OF THE GREAT LAKES.
Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Fisheries Research Branch.
For primary bibliographic entry see Field 5G.
W90-09360

THEORETICAL AND EXPERIMENTAL DRAWBACKS IN HEAVY METAL SPECIATION IN NATURAL WATERS.
Pisa Univ. (Italy). Dipt. di Chimica.
For primary bibliographic entry see Field 5C.
W90-09394

PARTITIONING OF HEAVY METALS INTO SELECTIVE CHEMICAL FRACTIONS IN SEDIMENTS FROM RIVERS IN NORTHERN GREECE.
Thessaloniki Univ., Salonika (Greece). Environmental Pollution Control Lab.
For primary bibliographic entry see Field 5B.
W90-09401

ATMOSPHERIC DEPOSITION AND THE CO-EFFICIENT OF NUTRIENT LEACHING (LE DEPOSITION ATMOSPHERIQUE ET LE CO-EFFICIENT DE LESSIVAGE DES NUTRI-ENTS).
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary). Inst. for Hydraulic Engineering.
For primary bibliographic entry see Field 5G.
W90-09429

CONTRIBUTION OF ACIDIC DEPOSITION ON HIGH ELEVATION FOREST CANOPY TO THE HYDROLOGIC CYCLE.
North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.
For primary bibliographic entry see Field 5B.
W90-09430

EFFECTS OF FOREST CANOPY ON THROUGHFALL PRECIPITATION CHEMISTRY.
Swiss Federal Inst. of Forestry Research, Birmensdorf.
For primary bibliographic entry see Field 5B.
W90-09431

FOLIAR ABSORPTION OF 15-N LABELED NITRIC ACID VAPOR (HNO3) IN MATURE EASTERN WHITE PINE (PINUS STROBUS L).
Southeastern Forest Experiment Station, Otto, NC. Coweeta Hydrologic Lab.
For primary bibliographic entry see Field 5B.
W90-09432

EFFECTS OF ACID RAIN AND FOREST DIE-BACK ON GROUNDWATER--CASE STUDIES IN BAVARIA, GERMANY (FRG).
Bayerisches Landesamt fuer Wasserwirtschaft, Munich (Germany, F.R.).
For primary bibliographic entry see Field 5C.
W90-09434

PESTICIDES IN TERRESTRIAL AND AQUATIC ENVIRONMENTS.
For primary bibliographic entry see Field 5B.
W90-09440

QUANTITATION OF NONPOINT SOURCE POLLUTION ASSOCIATED WITH CRANBERRY PRODUCTION IN MASSACHUSETTS.
Massachusetts Agricultural Experiment Station, East Wareham.
For primary bibliographic entry see Field 5B.
W90-09457

TOXICITY OF SELECTED UNCOUPLING AND ACETYLCHOLINE ESTERASE-INHIBITING PESTICIDES TO THE FATHEAD MINNOW (PIMEPHALES PROMELAS).
Wisconsin Univ.-Superior. Center for Lake Superior Environmental Studies.
For primary bibliographic entry see Field 5A.
W90-09465

INSECTICIDES FOR INSECT PEST CONTROL IN CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT: A DILEMMA.
Tennessee Valley Authority, Muscle Shoals, AL. Vector and Plant Management Program.
For primary bibliographic entry see Field 5D.
W90-09470

2I. Water In Plants

BREEDING FOR HEAT TOLERANCE: AN APPROACH BASED ON WHOLE-PLANT PHYSIOLOGY.
California Univ., Riverside. Dept. of Botany and Plant Sciences.
A. E. Hall.
Hortscience HJHSAR, Vol. 25, No. 1, p 17-26, January 1990. 4 fig, 2 tab, 83 ref.

Descriptors: *Crop production, *Drought resistance, *Heat tolerance, *Plant physiology, Air temperature, Drought effects, Genetics, Model studies, Research priorities, Seasonal variation, Turgor, Water deficit.

In hot environments, maintenance of plant productivity requires that limiting plant processes are not irreversibly damaged by heat. Consequently, in designing breeding programs to incorporate heat tolerance, the following points need to be addressed: (1) the types of hot weather occurring in production environments, considering day and night temperatures at different times during the season; (2) the extent to which they cause reduction in yield; (3) which stages of plant development and plant processes are most sensitive to high temperatures and are responsible for the reductions in yield; and (4) how is heat tolerance inherited, and whether there are any other characters associated with heat tolerance through genetic linkage or pleiotropy that influence crop adaptation or suitability as a cultivar. Artificial pollination established that excessive flower abscission and low pod set of plants subjected to high night temperature were due to male sterility. Sensitivity to heat during floral bud development only occurs in long days and not in short days. When choosing a measure of water status, it is essential to take note of the control mechanisms that influence the plant process of interest, which, for many purposes, will be development. Leaf water potential is rarely a useful quantity because of its correlation with turgor. Initial responses to water deficits may be very different than longer-term responses when adaptive processes, such as osmotic adjustments, occur. It is generally not feasible to conduct experiments on the scale that would be needed to determine the effect of widescale introduction of a new crop or cultivar over a large area extending over tens of square kilometers. The best approach available is to make use of the current level of understanding of the effects of scaling up and to incorporate this into models to predict the effect at the crop level of given changes, such as stomatal conductance or behavior, of response to stress. (Brunone-PTT)
W90-08893

ADAPTIVE STEM AND ADVENTITIOUS ROOT RESPONSES OF TWO TOMATO GENOTYPES TO FLOODING.
Purdue Univ., Lafayette, IN. Dept. of Horticulture.
S. T. McNamara, and C. A. Mitchell.
Hortscience HJHSAR, Vol. 25, No. 1, p 100-103, January 1990. 5 fig, 16 ref.

Descriptors: *Flooding, *Plant growth, *Plant morphology, *Plant water potential, *Tomatoes, Adventitious roots, Ethylene synthesis, Hypoxia, Root formation.

Tomato accessions PI 128644 (Lycopersicon peruvianum var. dentatum Mill.) and PI 406966 (Lycopersicon esculentum Mill.) were identified in preliminary screening trials as being relatively nonresistant and resistant to 120 hours of flooding, respectively. Many adventitious roots (AR) developed on the lower stems of flooded PI 406966 seedlings, while few formed on flooded PI 128644 plants. Root formation by flooded PI 406966 seedlings depended on de novo initiation rather than emergence of preformed initials. Hypocotyl porosity of PI 406966 plants increased from between 3% and 6% to 8% by 36 and 72 hours of flooding. Porosity of PI 128644 hypocotyls was unchanged by 72 hours of inundation. Flooding did not affect the secondary root porosity of either accession. The limited capacity of PI 128644 seedlings to develop AR and aerenchyma was not related to an inability to synthesize 1-aminocyclopropane-1-carboxylic acid or ethylene in response to hypoxia. (Author's abstract)
W90-08894

EVAPOTRANSPIRATION OF COOL-SEASON GRASSES GROWN WITH MINIMAL MAINTENANCE.
Oregon State Univ., Corvallis. Dept. of Horticulture.
J. A. Doty, W. S. Braunworth, S. Tan, P. B. Lombard, and R. D. William.
Hortscience HJHSAR, Vol. 25, No. 5, p 529-531, May 1990. 3 tab, 15 ref.

Descriptors: *Evapotranspiration, *Grasses, *Plant physiology, *Plant water potential, *Soil-water-plant relationships, Colonial bentgrass, Fescues, Irrigation, Mowing, Neutron probe, Ryegrass, Soil water.

Evapotranspiration (ET) of three perennial ryegrass (Lolium perenne L.) cultivars and one cultivar each of colonial bentgrass (Agrostis tenuis L.) and tall fescue (Festuca arundinacea L.) was measured in the field. Soil water depletion was measured with a neutron probe. Under minimal maintenance (i.e., no irrigation and infrequent mowing), ET was not significantly different for five perennial grasses. All grasses used more water than the bare-ground treatment. Soil water uptake was greatest in the upper soil layer (0 to 25 cm) and decreased with depth. Few differences in water uptake were noted among grasses within each soil layer. (Author's abstract)
W90-08895

SEQUENTIALLY ADDITIVE AND OTHER INTERACTIONS BETWEEN NITROGEN FERTILIZER AND IRRIGATION ON THE YIELD OF WHEAT GRAIN IN A FIELD IN KANSAS.
California Univ., Los Angeles. Lab. of Biomedical and Environmental Sciences.
For primary bibliographic entry see Field 3F.
W90-08904

YIELD AND QUALITY OF PROCESSING TOMATOES IN RESPONSE TO IRRIGATION RATE AND SCHEDULE.
North Carolina State Univ. at Raleigh. Dept. of Horticultural Science.
D. C. Sanders, T. A. Howell, M. M. S. Hile, L. Hodges, and D. Meek.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 114, No. 6, p 904-908, November 1989. 5 tab, 19 ref.

Descriptors: *Crop production, *Evapotranspiration, *Irrigation practices, *Plant water potential, *Tomatoes, Crop yield, Irrigation effects, Plant growth, Soil types, Trickle irrigation.

Field studies were conducted on a Typic Xerorthents Entisols soil (Hanford sandy loam) to determine the response of two cultivars of processing tomatoes (Lycopersicon esculentum Mill.) to trickle irrigation applied at three percentages of evapotranspiration (ET) to either the top of the plant row or between the beds using a traveling irrigation system. Irrigation was terminated when fruits were either 30% or 70% red (14 or 7 days before

harvest). Yields of red tomatoes and total tomatoes increased with increasing trickle irrigation water. The concentrations of soluble solids (SSC) and total solids (TS) and pH decreased with increasing trickle irrigation rates, while color, fruit size, and acidity increased, as did the yield of SSC and TS per hectare. Placement of trickle irrigation on the plant row was more favorable than placement in the furrow between the beds for yield and quality characteristics. Trickle irrigation to 70% ET terminated 7 days before harvest produced responses similar to conventional furrow irrigation. Although statistically these treatments could not be compared directly to conventional furrow, all traveling trickle irrigation rates were superior in water use efficiency to that of conventional furrow irrigation. Trickle irrigation rates of 35% ET, 70% ET and 105% ET did not differ in water use efficiency. (Author's abstract)
W90-08905

PACLOBUTRAZOL AND ROOT ZONE WATER CONTENT INFLUENCE PEACH SEEDLING BEHAVIOR.
Bologna Univ. (Italy). Ist. di Coltivazioni Arboree.
For primary bibliographic entry see Field 5C.
W90-08906

NET PHOTOSYNTHESIS AND STOMATAL CONDUCTANCE OF PEACH SEEDLINGS AND CUTTINGS IN RESPONSE TO CHANGES IN SOIL WATER POTENTIAL.
Georgia Agricultural Experiment Stations, Griffin.
R. D. Harrison, J. W. Daniell, and J. M. Cheshire.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 114, No. 6, p 986-990, November 1989. 2 fig, 4 tab, 26 ref.

Descriptors: *Peaches, *Photosynthesis, *Plant water potential, *Soil water potential, *Soil-water-plant relationships, *Stomatal transpiration, *Vapor pressure, Diurnal variation, Drought, Plant physiology, Seedlings.

Greenhouse-grown peach (Prunuspersica (L.) Batsch.) seedlings and cuttings were drought-stressed by reducing soil water potential from field capacity (FC) to permanent wilting point (PWP). Mean soil water potential and leaf water potential were correlated with measurements of stomatal conductance, net photosynthetic rate, and vapor pressure deficit. Decreasing net photosynthesis and stomatal conductance trends were noted as soil water potential decreased. Photosynthetic rate and stomatal conductance were significantly reduced at leaf water potential more negative than -1.5 MPa. Values of net photosynthesis and stomatal conductance were more highly correlated to leaf water potential than to soil water potential. A midday depression in net photosynthesis rates began two hours earlier and peak rates were at least 50% lower when soil water potential was more negative than -0.05 MPa. The correlation coefficient (r) between leaf and soil water potential and between stomatal conductance and net photosynthesis rate at different soil water potentials was above 0.70. The r values decreased as soil and plant water potential became more negative. Stomatal conductance peaked at optimal soil water potential (FC) 2 hours following sunrise. Photosynthetic rates peaked at a soil water potential around -0.05 MPa four hours after sunrise. (Author's abstract)
W90-08907

ANTITRANSPIRANT REDUCES WATER USE BY PEACH TREES FOLLOWING HARVEST.
Texas A and M Univ., College Station. Dept. of Agricultural Economics.
S. L. Steinberg, M. J. McFarland, and J. W. Worthington.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 115, No. 1, p 20-24, January 1990. 4 fig, 4 tab, 24 ref.

Descriptors: *Antitranspirants, *Peaches, *Plant physiology, *Plant water potential, Canopy, Crop production, Plant growth, Plant reproduction, Soil-water-plant relationships, Stomatal transpiration, Transpiration, Water stress, Weighing lysimeter.

The potential for reducing water use of peach (Prunus persica (L.) Batsch) trees with antitranspirants following fruit harvest was investigated using matched peach trees planted in an outdoor twin weighing lysimeter facility. A 10% solution of the antitranspirant Wilt Pruf NCF was applied to one of the two trees on July 7, 1986. Immediately after application, water use of the treated tree was reduced by 40%. One month after treatment, the water use was reduced 30% and, by the termination of the experiment (85 days after treatment), water use was reduced 12% as compared to control. The average reduction in tree water use, for the entire period was 30%. Fully expanded, sunlit leaves (nodes 10 to 20 from the terminal end) from the treated tree exhibited the greatest reduction in water loss compared with immature or inner canopy, shaded leaves. Use of the antitranspirant did not prevent the development of water stress once a critical level of soil moisture was reached. The change in tree water use induced by the transpirant did not significantly reduce shoot length, new leaf production, or individual leaf size on actively growing, current-season branches. Fruit and leaf bud initiation, as measured the following spring, were not affected; however, flower bud maturation could not be evaluated due to freeze damage. (Author's abstract)
W90-08908

MICROSPRINKLER IRRIGATION AND GROWTH OF YOUNG 'HAMLIN' ORANGE TREES.
Florida Univ., Gainesville. Dept. of Fruit Crops.
T. E. Marler, and F. S. Davies.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 115, No. 1, p 45-51, January 1990. 3 fig, 4 tab, 23 ref.

Descriptors: *Citrus crops, *Irrigation practices, *Plant growth, *Plant water potential, *Soil-water-plant relationships, *Sprinkler irrigation, Plant physiology, Seasonal variation, Soil water, Water conservation, Water deficit.

Growth responses of young 'Hamlin' orange (Citrus sinensis (L.) Osbeck) and sour orange (C. aurantium L.) trees to microsprinkler irrigation were studied under field conditions from 1985 to 1987 to determine the most efficient irrigation rates and duration. Trees were irrigated when available soil water depletion (SWD) reached 20% (high frequency), 45% (moderate frequency), and 65% (low frequency). Trees at the moderate and low levels received 49% and 13%, respectively, as much irrigation water as the high treatment. Canopy volume, trunk cross-sectional area, dry weight, shoot length, leaf area, total root dry weight and volume, and new root dry weight were similar for the high and moderate levels in 2 of 3 years, but were significantly reduced at the low levels. More than 90% of root dry weight was within 80 cm of the trunk at the end of the growing season. The optimum level of irrigation in this study was between 20% and 35% SWD, suggesting that microsprinkler irrigation every 4 to 6 days at 45% SWD is as effective as irrigating every 2 to 3 days at 20% SWD. This schedule results in a considerable reduction in irrigation water required. However, the final growth flush of some trees may be reduced at the moderate irrigation level, probably because of inherent variability in SWD among trees within the treatment. (Brunone-PTT)
W90-08909

IRRIGATION SCHEDULING MODEL FOR SNAP BEAN.
Georgia Coastal Plain Experiment Station, Tifton.
For primary bibliographic entry see Field 3F.
W90-08910

EFFECT OF ZERO AND CONVENTIONAL TILLAGE ON BARLEY YIELD AND NITRATE NITROGEN CONTENT, MOISTURE AND TEMPERATURE OF SOIL IN NORTH-CENTRAL ALBERTA.
Alberta Univ., Edmonton. Dept. of Soil Science.
M. Nyborg, and S. S. Malhi.
Soil and Tillage Research SOTRD5, Vol. 15, No. 1/2, p 1-9, December 1989. 5 tab, 18 ref.

Descriptors: *Barley, *Crop production, *Mulching, *Nitrates, *No-till cultivation, *Soil temperature, *Soil water, *Soil-water-plant relationships, *Tillage, Agriculture, Cultivation, Nutrient concentrations, Plant growth, Seasonal variation, Soil types.

Field experiments conducted on two soils (a Black Chernozemic and a Dark Grey Chernozemic soil) in north-central Alberta to compare the effects of zero tillage versus conventional tillage on grain yield of barley, on soil nitrate nitrogen content, and or soil temperature. There were two tillage treatments (zero and conventional tillage), two levels of straw (straw-on and straw-off), and two rates of applied nitrogen (0 and 112 kg nitrogen per hectare). The first crop after summer fallow did not respond to applied nitrogen and yields were similar among treatments. By the third crop, all tillage-straw treatments markedly responded to nitrogen. On plots without nitrogen, zero tillage produced significantly less yield than conventional tillage and straw-on treatment generally produced less yield than straw-off treatment. Yields on the zero tillage plots approached those of the conventional tilled plots. During the fallow year, conventional-tillage plots contained greater amounts of nitrate than the zero-tillage plots. That is, the net mineralization rate was greater with conventional tillage than with zero tillage. Soil temperature at the 5 cm and 10 cm depths was less on zero-tillage than on conventional-tillage plots and was compared to straw-off plots. The water holding capacity at minus 33 kPa of soil was higher on zero-tillage than the conventional-tillage plots. (Author's abstract)
W90-08914

RESIDUAL SOIL MOISTURE AND WHEAT YIELD IN RELATION TO MULCHING AND TILLAGE DURING PRECEDING RAINFED CROP.
Regional Research Station, Sirmur (India).
P. K. Sharma, P. C. Kharwara, and R. K. Tewatia.
Soil and Tillage Research SOTRD5, Vol. 15, No. 3, p 279-284, February 1990. 4 tab, 6 ref.

Descriptors: *Crop yield, *Mulching, *Soil water, *Soil-water-plant relationships, *Tillage, *Wheat, Agriculture, Corn, Crop production, Plant growth, Rainfall, Sandy loam.

In two field trials on sandy loam (Fluvent) soil, maize stalk mulch, generated in situ and applied at maize harvest, conserved more soil moisture than did the fallow control or repeated plowings and plankings. A sal leaf (Shorea robusta) mulch at 10 tons/ha was as effective as a maize stalk mulch, but had the disadvantage of cost and time incurred by its collection and transportation from the forest to the field. Combining tillage with mulching did not give any additional benefit. Maize stalk mulch, with or without tillage, conserved 35.6 and 63.6 mm more moisture per 450 mm of soil than did tillage treatments and fallow control in 1986 to 1987, between maize harvest and sowing of wheat. The corresponding moisture conservation in 1987 to 1988 was 16.8 and 26.0 mm, respectively. Mulch-induced residual soil moisture significantly increased the grain and straw yield of rainfed wheat. Wheat grain yield with a maize stalk mulch was 19% higher than with tillage treatments, and 52% higher than in the fallow control in 1986 to 1987. The corresponding increase in grain yield in 1987 to 1988 was 30 and 195%. (Author's abstract)
W90-08917

SHORT-TERM ESTIMATION OF SORGHUM EVAPOTRANSPIRATION FROM CANOPY TEMPERATURE.
Texas Agricultural Experiment Station, Temple. Blackland Research Center.
For primary bibliographic entry see Field 2D.
W90-08920

EVALUATING WATER FLUXES OF FIELD-GROWN ALFALFA FROM DIURNAL OBSERVATIONS OF NATURAL ISOTOPE CONCEN-

Group 2I—Water In Plants

TRATIONS, ENERGY BUDGET AND ECO-PHYSIOLOGICAL PARAMETERS.
Paris-6 Univ. (France). Lab. de Biogeochmie des Isotopes Stables.
For primary bibliographic entry see Field 2D.
W90-08922

INFLUENCE OF WATER DEFICIT ON TRANSPIRATION AND RADIATION USE EFFICIENCY OF CHICKPEA (CICER ARIETINUM L).
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).
P. Singh, and Y. V. Sri Rama.
Agricultural and Forest Meteorology AFMEEB, Vol. 48, No. 3/4, p 317-330, November 1989. 6 fig, 3 tab, 19 ref.

Descriptors: *Crop production, *Evapotranspiration, *Legumes, *Plant physiology, *Plant water potential, *Seasonal variation, *Stomatal transpiration, Biomass, Correlation analysis, Mathematical models, Soil water, Solar radiation.

Information on the relationship between biomass production, radiation use, and water use of chickpea (Cicer arietinum L.) is essential to estimate biomass production in different water regimes. Experiments were conducted during three post-rainy seasons on a Vertisol (a typic pallustert) to study the effect of water deficits on radiation use, radiation use efficiency (RUE), transpiration and transpiration efficiency (TE) of chickpea. Different levels of soil water availability were created, either by having irrigated and non-irrigated plots or using a line source. Biomass production was linearly related to both cumulative intercepted solar radiation and transpiration in both well watered and water deficit treatments. Soil water availability did not affect RUE (total dry matter produced per unit of solar radiation interception) when at least 30% of extractable soil water (ESW) was present in the rooting zone, but below 30% ESW, RUE decreased linearly with the decrease in soil water content. RUE was also significantly correlated (R squared $=0.61$, $P < 0.01$) with the ratio of actual to potential transpiration (T/Tp) and it declined curvilinearly with the decrease in T/Tp. TE decreased with the increase in saturation deficit (SD) of air. Normalization of TE with SD gave a conservative value of 4.8 g kPa/kg. To estimate biomass production of chickpea in different environments, the effects of plant water deficits on RUE must be accounted for in a radiation-based model and the effect of SD on TE must be accounted for in a transpiration-based model. (Author's abstract)
W90-08923

EVAPORATION FROM IRRIGATED WHEAT ESTIMATED USING RADIATIVE SURFACE TEMPERATURE: AN OPERATIONAL APPROACH.
Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Centre for Irrigation Research.
For primary bibliographic entry see Field 3F.
W90-08924

WATER USE BY SHRUBS AS AFFECTED BY ENERGY EXCHANGE WITH BUILDING WALLS.
Texas A and M Univ., College Station. Dept. of Soil and Crop Sciences.
J. L. Heilman, C. L. Brittin, and J. M. Zajicek.
Agricultural and Forest Meteorology AFMEEB, Vol. 48, No. 3/4, p 345-357, November 1989. 10 fig, 3 tab, 19 ref.

Descriptors: *Buildings, *Landscaping, *Plant water potential, *Urban areas, *Water use, Net radiation, Reflected radiation, Temperature, Texas, Wind.

Landscape plants in urban areas are routinely grown next to buildings which are sources of sensible heat and radiation. An experimental study was conducted from mid-June to early July in Texas to explore how building walls affect water use by adjacent landscape plants. Instantaneous rates of sap flow were measured using heat balance, stem flow gauges attached to wax leaf ligustrum shrubs growing adjacent to all four walls of a building shell. For comparison, sap flow was also measured on shrubs grown away from the influence of the building. Peak flow in plants adjacent to each wall occurred when direct beam irradiance on the wall and wall temperature were at their maxima. Peak flow was highest in plants adjacent to east and west walls, and lowest in plants adjacent to the north wall. Longwave radiation emitted by the walls appeared to be a major factor affecting flow while reflected radiation from walls was of secondary importance because of the low albedo of the walls. Cumulative flow was greatest in the shrubs grown away from the influence of the building, probably due to the absence of any shading by walls during the day, and to wind speeds that were higher than those adjacent to the building. (Author's abstract)
W90-08925

APPLICATION OF AN ENERGY COMBINATION MODEL FOR EVAPORATION FROM SPARSE CANOPIES.
Trent Univ., Peterborough (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2D.
W90-08926

SAP FLOW IN THE STEM OF WATER STRESSED SOYBEAN AND MAIZE PLANTS.
Agricultural Research Organization, Bet-Dagan (Israel). Inst. of Soils and Water.
Y. Cohen, M. G. Huck, J. D. Hesketh, and J. R. Frederick.
Irrigation Science IRSCD2, Vol. 11, No. 1, p 45-50, 1990. 7 fig, 1 tab, 16 ref.

Descriptors: *Irrigation, *Maize, *Plant physiology, *Sap flow, *Sorghum, *Water stress, Photosynthesis, Soil water potential, Transpiration.

Water stress was imposed on soybean (Glycine max (L.) Merr. cv. Williams) and maize (Zea mays L. cv. Pioneer 3377) plants grown under controlled-environment conditions during a growing period of several irrigation cycles. Transpiration rates of individual plants were measured with a calibrated heat-pulse method and correlated to the rate of water loss obtained from successive weights of the pots containing water stressed plants. Transpiration rate was reduced in the stressed plants of both species, but the reduction was not linear with decreasing soil matric potential and dropped more slowly as the soil dried. Although measured transpiration rate declined by nearly 30% following a reduction of soil matric potential to -0.1 MPa, differences in leaf water potential an CO2 assimilation rate were small and less than the sensitivity of the measurement techniques used. Total system resistance to water flow increased as the soil dried. (Author's abstract)
W90-08955

PLANT WATER RELATIONS AND NUTRIENT UPTAKE IN FRENCH BEAN.
Indian Inst. of Horticultural Research, Bangalore. Div. of Soil Science.
D. M. Hegde, and K. Srinivas.
Irrigation Science IRSCD2, Vol. 11, No. 1, p 51-56, 1990. 2 fig, 5 tab, 14 ref.

Descriptors: *Beans, *Crop yield, *Nutrients, *Plant physiology, *Plant water potential, Evapotranspiration, Fertilizers, Irrigation efficiency, Nitrogen, Soil water potential, Water stress, Water use efficiency.

Field investigations carried out in 1985-1986 and 1986-1987 with French bean (Phaseolus vulgaris L.) crops indicated that irrigation when soil matric potential at the 0.15-m level reached -45 kPa resulted in the highest dry matter production, green pod yield, nutrient uptake, and water use efficiency (WUE) compared to irrigations scheduled at -65 or -85 kPa. The difference in pod yield between irrigations scheduled at -25 and -45 kPa was not significant. Increasing soil moisture stress increased the canopy temperature and adversely affected plant water relations. There was a quadratic relationship between green pod yield and evapotranspiration (ET) and the yield-maximizing ET ranging between 268 and 299 mm. Nitrogen fertilization significantly increased green pod yield, nutrient uptake, and WUE but had no marked effect on water relations and canopy temperature. (Author's abstract)
W90-08956

MUNGBEAN RESPONSE TO IRRIGATION WITH WATERS OF DIFFERENT SALINITIES.
Central Soil Salinity Research Inst., Karnal (India).
For primary bibliographic entry see Field 3F.
W90-08957

GROWTH, YIELD AND SOIL WATER EXTRACTION OF IRRIGATED AND DRYLAND PEANUTS IN SOUTH SULAWESI, INDONESIA.
Balai Penelitian Tanaman Pangan Maros, Ujung Pandang (Indonesia).
For primary bibliographic entry see Field 3F.
W90-08958

EFFECT OF SOIL MATRIC POTENTIAL AND NITROGEN ON GROWTH, YIELD, NUTRIENT UPTAKE AND WATER USE OF BANANA.
Indian Inst. of Horticultural Research, Bangalore. Div. of Soil Science.
For primary bibliographic entry see Field 3F.
W90-09013

MODELING WATER TABLE CONTRIBUTION TO CROP EVAPOTRANSPIRATION.
Utah State Univ., Logan. Dept. of Soil Science and Biometeorology.
For primary bibliographic entry see Field 2D.
W90-09018

GROWTH AND NITROGEN ECONOMY OF RICE UNDER SPRINKLER AND FLOOD IRRIGATION IN SOUTH EAST AUSTRALIA: III. 15N BALANCE.
Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Centre for Irrigation Research.
For primary bibliographic entry see Field 3F.
W90-09019

IRRIGATION STUDIES ON WATERMELON (CITRILLUS LANATUS (THUNB) MATSUM ET NAKAI).
Indian Inst. of Horticultural Research, Bangalore. Div. of Soil Science.
For primary bibliographic entry see Field 3F.
W90-09020

INFLUENCE OF WATER STRESS ON KIWI-FRUIT GROWTH.
Ruakura Agricultural Research Center, Hamilton (New Zealand).
For primary bibliographic entry see Field 3F.
W90-09021

SALT SENSITIVITY OF COWPEA AT VARIOUS GROWTH STAGES.
Agricultural Research Service, Riverside, CA. Salinity Lab.
E. V. Maas, and J. A. Poss.
Irrigation Science IRSCD2, Vol. 10, No. 4, p 313-320, 1989. 1 fig, 4 tab, 17 ref.

Descriptors: *Legumes, *Plant growth, *Salt tolerance, Irrigation, Plant pathology, Salinity.

The relative salt tolerance of cowpea (Vigna unguiculata (L.) Walp. cv. California Buckeye No. 5) at different stages of growth was determined in a greenhouse. Plants were grown in sand cultures that were irrigated four times daily with modified half-strength Hoagland's solution. Salination with NaCl and CaCl2 (2:1 molar ratio) provided seven treatment solutions with osmotic potentials (OP) ranging from -0.05 to -1.05 MPa (electrical con-

ductivities of 1.4 to 28 dS/m). Salt stress was imposed for 20 days beginning at either 7, 27, or 52 days after planting. The three 20-day stages are referred to here as vegetative, flowering, and pod-filling stages. Pod and seed yields from plants stressed during either the vegetative, flowering, or pod-filling stages indicated that cowpea was the most sensitive to salinity during the vegetative stage and became less sensitive the later plants were stressed. Seed yield was reduced 50% at OP - 0.45, -0.76, and -0.88 MPa for plants salinized during the vegetative, and pod-filling stages, respectively. Salinity reduced seed yield by reducing seed number. It had little, if any effect, on the weight of individual seeds. Vegetative growth was reduced significantly by salt stress during all three stages, but the effect was much less when stress was imposed during the last two stages than during the first stage. (Author's abstract)
W90-09022

ERRORS IN THE ESTIMATION OF PRE-EXCISION PLANT WATER POTENTIAL.
Agricultural Research Service, Tucson, AZ.
S. P. Hardegree.
Irrigation Science IRSCD2, Vol. 10, No. 4, p 321-329, 1989. 3 fig, 1 tab, 19 ref.

Descriptors: *Laboratory methods, *Pine trees, *Plant physiology, *Plant water potential, Errors, Measuring instruments, Pressure chambers, Psychrometers.

Over the same water potential range, Pinus ponderosa (Laws.) seedling shoots lost less water when dried by sap expression than when air dried either before or after shoot excision. It is hypothesized that this phenomenon was caused by air in the xylem elements of air-dried tissue and entrapment of the air during subsequent pressure chamber measurements. When shoots were dried by sap expression and pressure was released, the shoot water potential estimate became less negative unless pressure was reapplied immediately. The pressure chamber reading of shoots dried intact, however, did not change after 1 hr of equilibration at atmospheric pressure. It was concluded that there was air in the xylem of intact-dried shoots before excision but little or no air entry into xylem elements after excision. For the seedling shoots used in this study, therefore, it would be appropriate to calibrate the pressure chamber with thermocouple psychrometer measurements. (Author's abstract)
W90-09023

RESTORATION OF AN IMPOUNDED SALT MARSH IN NEW ENGLAND.
Connecticut Coll., New London. Dept. of Botany.
For primary bibliographic entry see Field 2L.
W90-09041

VEGETATION, WATER, AND CLIMATIC CHANGE.
Akademiya Nauk SSSR, Moscow. Inst. Geografii.
For primary bibliographic entry see Field 2A.
W90-09093

BEHAVIOR OF HEAVY METALLIC ELEMENTS IN PLANTS: I. THE UPTAKE OF HEAVY METALLIC ELEMENTS BY AQUATIC PLANTS.
Yamagata Univ. (Japan). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W90-09120

INFLUENCE OF TEMPERATURE VARIATIONS ON INTERCEPTION LOSS AND WATER STORAGE IN VEGETATION CANOPIES.
Leeds Univ. (England). School of Geography.
J. G. Lockwood.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 941-943, May 1990. 2 tab, 9 ref.

Descriptors: *Canopy, *Interception, *Model studies, *Rainfall, *Temperature, *Trees, *Vegetation, *Water loss, *Water storage, Coniferous forests,

Evaporation, Forests, Mathematical studies, Numerical models, Pine trees, Precipitation.

A multilayer numerical model was used to explore variations in interception loss with temperature in a pine canopy. Results showed that if incoming radiation is kept at the realistically low levels associated with temperature latitude rainfall events, then interception loss tends to decrease in a nonlinear fashion with increasing temperature. As the canopy becomes warmer, its long-wave emission increases, and the available energy at the evaporating surfaces declines. If other meteorological conditions are kept constant, increasing temperature is associated with an increasing tendency for intercepted rainwater to be stored in the lower parts of the canopy for long periods, while the upper canopy dries relatively quickly. In a humid atmosphere with higher temperatures, interception loss during and after rainfall events is concentrated toward the top of the canopy with condensation and extended storage in lower layers. (Cassar-PTT)
W90-09167

STRONTIUM ISOTOPE STUDIES OF ATMOSPHERIC INPUTS TO FORESTED WATERSHEDS IN NEW MEXICO.
New Mexico Univ., Albuquerque. Dept. of Biology.
For primary bibliographic entry see Field 2K.
W90-09265

DENITRIFICATION AND DINITROGEN FIXATION IN TWO QUAKING FENS IN THE VECHTPLASSEN AREA, THE NETHERLANDS.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Plant Ecology.
For primary bibliographic entry see Field 2H.
W90-09267

MOLECULAR CLONING OF A PLANT BETAINE-ALDEHYDE DEHYDROGENASE, AN ENZYME IMPLICATED IN ADAPTATION TO SALINITY AND DROUGHT.
MSU/DOE Plant Research Lab., East Lansing, MI.
E. A. Weretilnyk, and A. D. Hanson.
Proceedings of the National Academy of Sciences of the United States of America PNASA6, Vol. 87, No. 7, p 2745-2749, 1990. 4 fig, 42 ref. U.S. Department of Energy Contract DOE-AC02-76ERO-1338, U.S. Department of Agriculture Grant 87-CRCR-1-2460, and Natural Sciences and Engineering Research Council of Canada Grant OGP-0043713.

Descriptors: *Drought resistance, *Enzymes, *Genetic engineering, *Osmosis, *Plant physiology, *Salt stress, Amino acid sequence, Betaine-aldehyde dehydrogenase, Molecular cloning, Spinach.

Many plants, as well as other organisms, accumulate betaine (N,N,N-trimethlyglycine) as a nontoxic or protective osmolyte under saline or dry conditions. In plants, the last step in betaine synthesis is catalyzed by betaine-aldehyde dehydrogenase (BADH, EC 1.2.1.8), a nuclear-encoded chloroplastic enzyme. A cDNA clone for BADH (1812 base pairs) was selected from a lambda gt10 cDNA library derived from leaves of salt-stressed spinach (Spinacia oleracea L.). The library was screened with oligonucleotide probes corresponding to amino acid sequences of two peptides prepared from purified BADH. The authenticity of the clone was confirmed by nucleotide sequence analysis; this analysis demonstrated the presence of a 1491-base-pair open reading frame that contained sequences encoding 12 peptide fragments of BADH. The clone hybridized to a 1.9 kilobase mRNA from spinach leaves; this mRNA was more abundant in salt-stressed plants, consistent with the known salt induction of BADH activity. The amino acid sequence deduced from the BADH cDNA sequence showed substantial similarities to those for nonspecific aldehyde dehydrogenases (EC 1.2.1.3 and EC 1.2.1.5) from several sources, including absolute conservation of a decapeptide in the probable active site. Comparison of deduced

and determined amino acid sequences indicated that the transit peptide may comprise only 7 or 8 residues, which is atypically short for precursors to stromal proteins. (Author's abstract)
W90-09283

VARIATION IN SOME ELEMENT CONTENTS OF WATER HYACINTH DUE TO CADMIUM OR NICKEL TREATMENT WITH OR WITHOUT ANIONIC SURFACE ACTIVE AGENTS.
Okayama Univ. (Japan). Research Inst. for Bioresources.
For primary bibliographic entry see Field 5B.
W90-09321

RESPONSE OF GROUNDNUT TO DROUGHT STRESS IN DIFFERENT GROWTH PHASES.
Andhra Pradesh Agricultural Univ., Hyderabad (India). Dept. of Plant Physiology.
P. S. Sarma, and M. V. K. Sivakumar.
Agricultural Water Management AWMADF, Vol. 15, No. 3, p 301-310, May 1989. 4 fig, 4 tab, 16 ref.

Descriptors: *Crop yield, *Drought effects, *India, *Peanuts, *Plant growth, Agronomy, Growth stages, Irrigation efficiency, Seeds, Tropical regions, Water stress.

The response of groundnut (Arachishypogaea L.) cultivar Robut 33-1 to drought stress imposed at different growth phases was studied during the 1982-83 post-rainy season on a medium deep Alfisol at the International Crops Research Institute for the Semi-Arid Tropics Center, Patancheru, India. Irrigation amount was varied to three levels for the growth phases: (1) emergence to flowering; (2) emergence to pegging; (3) start of flowering to start of seed growth; and (4) emergence to maturity. Soil water extraction in treatments 1 and 2 was mostly from the surface 60 cm of soil, whereas in treatment 3 extraction from the 60-120 cm soil layer was significantly higher. Total water use varied with the growth phase and also with the intensity of drought stress within a growth phase. Stress imposed in treatment 2 resulted in increases in pod number and dry matter. Significantly higher pod and kernel yields were obtained in treatment 2. Quality of kernels was also superior in treatment 2, as shown by the improved seed weight, oil, and protein contents, and the percentage of seed to pod weight. In treatment 3, low yields and a lower percentage of sound mature kernels were observed. Drought stress imposed from flowering to start of seed growth was shown to be important for both yield and quality. (Author's abstract)
W90-09368

2J. Erosion and Sedimentation

PHYSICAL CHARACTERISTICS OF SALT MARSH SEDIMENTS: ECOLOGICAL IMPLICATIONS.
South Carolina Univ., Columbia. Dept. of Marine Science.
P. M. Bradley, and J. T. Morris.
Marine Ecology Progress Series MESEDT, Vol. 61, No. 3, p 245-252, 1990. 2 fig, 4 tab, 29 ref. NSF contract BSR-8317407.

Descriptors: *Salt marshes, *Sediment analysis, *Sediment chemistry, Clays, Correlation analysis, Drainage, Evapotranspiration, Interstitial water, Oxidation, Sand, Sediment compressibility, Silt, Sulfates.

The physical characteristics of four sediment types commonly found in the southeastern United States salt marshes and their relationship to sediment drainage and compressibility were measured. Compressibility was positively correlated with total silt-clay content (correlation coefficient (r sq)=0.953) and negatively correlated with total sand content (r sq = 0.942). A linear relationship (r sq = 0.832) was found between the square root of sediment percolation velocity and bulk density. Calculations of the rate of air entry and porewater turnover based on measurements of drainage and compressibility were consistent with the supply of SO4(2-) necessary to support the rates of SO4(2-) reduction

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found at North Inlet, South Carolina, by previous researchers and indicate that compressibility may regulate the turnover of reduced end products such as pyrite. For incompressible sediments, it was demonstrated that the entry of air into sediments following water loss by evapotranspiration is quantitatively important in oxidizing reduced sulfur compounds, while drainage of compressible creek bank sediments is apparently sufficient to replace $SO_4(2-)$ utilized by dissimilatory $SO_4(2-)$ reducers. (Author's abstract)
W90-08718

EVALUATION OF TRANSPORT AND STORAGE OF (60)CO, (134)CS, (137)CS AND (65)ZN BY RIVER SEDIMENTS IN THE LOWER SUSQUEHANNA RIVER.
Maryland Dept. of Natural Resources, Annapolis. Power Plant and Environmental Review Div.
For primary bibliographic entry see Field 5B.
W90-08731

FIELD MEASUREMENTS OF SEDIMENT TRANSPORT PARAMETERS IN ESTUARIES.
Birmingham Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W90-08736

CHANNEL EROSION ANALYSIS AND CONTROL.
Army Engineer District, Omaha, NE.
J. C. Fischenich.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 101-109, 1 fig, 1 tab, 6 ref.

Descriptors: *Channel erosion, *Erosion control, *Headwaters hydrology, *Management planning, *Missouri River, Bank erosion, Bank protection, Decision making.

Channel erosion, including erosion of the stream's bed and banks, is a very significant problem on many waterways in the upper Missouri River Basin. It causes direct loss of productive land and facilities, accelerated reservoir storage depletion, habitat loss, decreased channel stability, and lowered groundwater tables. The Omaha District of the Corps of Engineers has developed a methodology for addressing channel erosion and selecting remedial measures. The foundation of the method is the determination of the mode and cause of the bank failure. Based upon this determination, a list of potential solutions is formulated. The list is then subjected to an analysis to determine which potential solutions best meet all of the factors and criteria for that particular project. Based upon this analysis, the best alternative is selected. A major advantage to this approach is that criteria for alternative evaluation can be pre-established. In fact, this process lends itself to a flowchart or computer artificial intelligence analysis format. Other benefits of a systematic approach such as this include reduced potential for alternative selection mistakes, reduced time and cost requirements for analysis, and reproducible analyses. It also provides a vehicle for senior engineers to pass on their experience in the form of analysis guidelines. (See also W90-08822) (Lantz-PTT)
W90-08833

FOREST HEADWATERS RIPARIAN ROAD CONSTRUCTION AND TIMBER HARVEST GUIDELINES TO CONTROL SEDIMENT.
Bitterroot National Forest, Hamilton, MT.
For primary bibliographic entry see Field 4D.
W90-08836

LANDSLIDE DEPOSITS IN LOW-ORDER STREAMS--THEIR EROSION RATES AND EFFECTS ON CHANNEL MORPHOLOGY.
Washington Univ., Seattle. Dept. of Geological Sciences.
S. J. Perkins.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 173-182, 6 fig, 2 tab, 13 ref.

Descriptors: *Channel morphology, *Erosion rates, *Headwaters hydrology, *Landslides, Channel erosion, Channel stability, Erosion, Mathematical models, Model studies, Sedimentation, Stream channels.

Erosion rates were measured for eight 1-year-old to 7-year-old landslide deposits in four stream channels. Once debris dams (if present) were breached, the deposits eroded rapidly, with 20 to 80% of initial volume removed in less than seven years. Erosion slowed markedly once stable channel geometries developed. A model is presented which describes the fluvial erosion of landslide deposits, and the long-term effects of landslide sediment on valley floor and channel morphology. The diffusion-erosion model of Begin et al., is applied to the erosion of landslide deposits. Diffusion-erosion coefficients are determined, and suggestions are made for using the method to predict erosion rates of landslide deposits. (See also W90-08822) (Author's abstract)
W90-08841

DETERMINING AVERAGE ANNUAL SEDIMENT YIELD FROM A BASIN DUE TO RAINFALL.
HydroDynamics, Inc., Parker, CO.
J. S. Fifield.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 183-191, 1 fig, 2 tab, 5 ref.

Descriptors: *Erosion, *Headwaters hydrology, *Mathematical analysis, *Mathematical equations, *Rainfall erosion, *Sediment yield, Erosion control, Flow pattern, Rainfall, Sedimentation, Slope degradation, Slopes, Soil erosion.

For lands undergoing development, regulatory agencies need a quick method to determine sediment yield resulting from rainfall erosion. Different methods exist to determine sediment yield but most require analyses of data collected, over a long time period, from the disturbed lands. By incorporating SCS Curve Number Method theory with the Modified Universal Soil Loss Equation, a technique has been developed where sediment yield can be determined knowing average basin slope, flow path length, basin area and erosion control parameters. The technique is applied to a developing watershed and an explanation is given about how the technique can be simplified for use in larger areas such as counties. Finally, examples are provided illustrating its usefulness in evaluating how sediment due to rainfall can be controlled in a watershed. (See also W90-08822) (Author's abstract)
W90-08842

USING THE USLE TO DISCUSS THE CAUSES OF SEDIMENTATION IN GUAM, MARIANA ISLANDS.
Guam Univ., Agana. Water and Energy Research Inst. of the Western Pacific.
R. L. Hunter-Anderson, and S. Khosrowpanah.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 193-201, 2 fig, 15 ref.

Descriptors: *Erosion, *Guam, *Headwaters hydrology, *History, *Sedimentation, *Soil erosion, *Universal Soil Loss Equation, Clear-cutting, Earthquakes, Rainfall.

The indigenous culture of Guam is at least three thousand years old. Recent research shows that a thick layer of terrigenous clay alluvium with archaeological materials overlies marine sands and estuarine deposits. Dating of these remains by radiocarbon gives an age of approximately 600 A.D. The causes of the prehistoric sedimentation of Guam's southern coast were studied using the USLE (Universal Soil Loss Equation) as a guide. It has been suggested that prehistoric farming practices, particularly fine and clear-cutting of upland forests, led to erosional deposition of the inland soils in coastal settings. In the USLE, these practices are subsumed by conservation-practice and cover-management. Another explanation holds that physical causes are responsible, such as an increase in slope due to uplift and a drier than normal climate resulting in higher soil erodibility. In the USLE these are subsumed under length-slope, rainfall-runoff erosivity index, and soil erodibility (K). Different values of the USLE factors, derived from the two explanations, are assigned and several runs of the USLE are performed. The results with these additional factors, indicate that a predicted amount of deposit of 147,015 tons is in fact greater then what was actually deposited. It is possible that other factors were different than estimated, such as an extended period of more intense and/or frequent storms, creating a higher rainfall index. Another possible factor that may have changed is slope; slope can be changed through tectonic uplift and eustatic actions. Finally, earthquakes similar to or greater than the frequency and magnitude recorded over the last century may have served to increase the sediment rate in the study area. (See also W90-08822) (Lantz-PTT)
W90-08843

EFFECT OF A LOG-JAM BURST ON BEDLOAD TRANSPORT AND CHANNEL CHARACTERISTICS IN A HEADWATERS STREAM.
Montana Dept. of State Lands, Helena.
N. Bugosh, and S. G. Custer.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 203-211, 5 fig, 1 tab, 15 ref.

Descriptors: *Bed load, *Channel morphology, *Headwaters hydrology, *Log jams, *Sediment transport, Gallatin River, Montana, Sediment discharge, Squaw Creek, Stream discharge.

Hydraulic factors are commonly assumed to exercise primary control on sediment transport in high-gradient headwaters streams. Research in 1983 and 1984 on Squaw Creek, a tributary to the Gallatin River in Montana, has shown that other hydrologic and geomorphic factors are also important. One of these factors is log-jams. A log-jam functions as a sediment storage area and as a local base level. The catastrophic dispersal of an old-jam in the study reach was observed and recorded during 1983. The log-jam broke when discharge was 6.4 cu m/s. A pulse of sediment was released from storage. One side of the channel was filled and channel morphology was altered. As the stream adjusted to the new morphology, average bedload transport was as high as 0.4 kg/m/s. This rate is at least two times the bedload transport rate measured at similar and higher discharges during runoff in 1983 and 1984. Thirty percent of the measured bedload in 1983 moved in a three day period and is directly attributable to the burst of the log-jam. The dispersal of this log-jam and the resulting instantaneous changes in bedload transport parameters had a greater effect on bedload in Squaw Creek more than any other parameter studied. Log-jam breakage affects bedload in Squaw Creek than any other parameter studied. Log-jam breakage affects bedload availability, bedload transport and channel characteristics in headwater streams. (See also W90-08822) (Author's abstract)
W90-08844

SUSPENDED SEDIMENT AND TURBIDITY FROM NORTHERN YELLOWSTONE PARK, WYOMING, 1985-1987.
Yellowstone National Park, WY. Research Div.
R. Ewing, and J. Mohrman.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 213-222, 3 fig, 2 tab, 11 ref.

Descriptors: *Headwaters hydrology, *Sediment load, *Suspended sediments, *Turbidity, Erosion, Precipitation, River sediments, Seasonal variation, Sediment transport, Wyoming, Yellowstone Park, Yellowstone River.

In response to public concerns that sediment loads in the Yellowstone River in and near Yellowstone National Park were increasing, the National Park Service joined with several Federal, state, and local agencies and private groups to gather baseline information in 1985, 1986, and 1987. Suspended sediment and turbidity were measured in the Yellowstone River and selected tributaries from Lake Yellowstone to Livingston, MT. Samples collected by the National Park Service and Soil Conservation Service were analyzed by the U.S. Geological Survey for suspended sediment, and the Park Service measured the turbidity. Results reflect river conditions in average, wet, and dry years (1985, 1986, 1987). Seasonal precipitation trends showed increases in summer precipitation in recent years. Results suggest that major amounts of suspended sediment and turbidity result from geologic processes operating in steep, mountainous terrain on erodible materials in high precipitation areas. Lower elevation areas also produce significant sediment where there are Cretaceous-aged shales and steep slopes. (See also W90-08822) (Author's abstract)
W90-08845

EFFECTS OF LAND USE ON SEDIMENT YIELD, SOUTHEASTERN COLORADO.
Geological Survey, Pueblo, CO.
P. von Guerard.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 233-241, 3 fig, 3 tab, 5 ref.

Descriptors: *Colorado, *Headwaters hydrology, *Land use, *Sediment yield, Agricultural practices, Catchment areas, Environmental effects, Precipitation, Vegetation.

In 1982, the U.S. Army acquired 987 sq km of semiarid rangeland (Pinon Canyon Maneuver Site) in southeastern Colorado for mechanized military maneuvers. Mean annual sediment yields were estimated for 21 small drainage basins at the Maneuver Site, which ranged in size from 0.26 to 3.11 sq km, by a the method developed by the Pacific Southwest Inter-Agency Committee (PSIAC). During the premaneuver period, 1983-85, estimated mean annual sediment yields for the basins ranged from 0.000040 to 0.000317 cu hectometer/ sq km. Postmaneuver mean annual sediment yields were estimated by evaluating changes in the PSIAC rating factors for ground cover, land use, and upland erosion. Postmaneuver estimates were compared with premaneuver estimates and were larger for 2 drainage basins, smaller for 18 drainage basins, and unchanged for 1 drainage basins. The general decrease in sediment yields resulted from the cessation of livestock grazing and from average or greater than average precipitation during the postmaneuver growing seasons. This resulted in improved ground-cover and land-use ratings and decreased estimated mean annual sediment yields. (See also W90-08822) (Author's abstract)
W90-08846

SURFACE AND GROUND WATER ASSESSMENTS SUPPORTING INSTREAM FLOW PROTECTION AT THE HASSAYAMPA RIVER PRESERVE, WICKENBURG, ARIZONA.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
M. E. Jenkins.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 307-316, 7 fig, 4 tab, 7 ref.

Descriptors: *Ephemeral streams, *Headwaters hydrology, *Instream flow, *Surface-groundwater relations, *Water management, Aquifers, Geohydrology, Groundwater mining, Groundwater movement, Hydrologic regime, Piezometers, Stream gages.

The Arizona Nature Conservancy's Hassayampa River Preserve is 50 miles northwest of Phoenix near the town of Wickenburg. Four miles of the largely ephemeral Hassayampa River are perennial within the preserve, supporting one of the state's

finest remaining cottonwood-willow forests. Stream flows are affected by wells pumping groundwater directly from the alluvial aquifer and may be influenced by wells which intercept lateral inflow from the regional basin-fill aquifer. Developing effective management strategies to protect base flow conditions (approximately 4 cfs) depends on a clear understanding of the preserve's surface and groundwater systems. Piezometers installed in conjunction with a continuously recording stream gage monitor riparian water-table elevations. Geologic cross-sections defining aquifer geometry have been developed from seismic refraction data, providing accurate estimates of sub-flow through the study area. Structural controls and changing evapotranspiration rates produce downstream variations and diminish base flow within the preserve. Groundwater hydrographs for wells within and near the alluvial aquifer have not exhibited significant declines in the last ten years, however, wells in the regional aquifer near Wickenburg have. Provided that groundwater development near Wickenburg recognizes and incorporates the interconnected nature of each hydrologic system, perennial flow within the preserve is not believed to be immediately threatened. (See also W90-08822) (Author's abstract)
W90-08854

DEVELOPMENT OF A SEDIMENT METHODOLOGY IN ALASKA.
Bureau of Land Management, Anchorage, AK. Alaska State Office.
R. F. Dworsky, and H. Levine.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 413-418, 9 ref.

Descriptors: *Alaska, *Headwaters hydrology, *Placer mining, *River sediments, *Sediment load, Environmental impact statement, Management planning, Model studies, Water quality.

In 1987, the Bureau of Land Management was ordered by the U.S. District Court to prepare cumulative environmental assessments of placer gold mining on four watersheds in central Alaska. Although placer gold mining has taken place in these streams since the early 1900's, limited research had been accomplished. One of the major issues of the lawsuit was the water quality impacts of placer gold mining by sedimentation. The environmental impact statement team was faced with a fundamental question: Could a sediment loading model be developed without having to commit many years and hundreds of thousands of dollars on new research. In 1973, the Environmental Protection Agency estimated the various rates of erosion from various land uses. While this data is based on nationwide rates and does not specifically represent Alaska, it does provide a set of parameters that can be used as a comparison. This comparison focuses on the relative contribution of ongoing and historic placer operations so that proposed future contributions can be placed in perspective. As a result an adequate management program was developed. (See also W90-08822) (Author's abstract)
W90-08864

GEOMORPHICALLY DETERMINED VALLEY-EROSION THRESHOLD FOR RECLAIMED SURFACE-MINED DRAINAGE BASINS, NORTHWESTERN COLORADO.
Geological Survey, Denver, CO.
J. G. Elliott.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 419-429, 3 fig, 1 tab, 11 ref.

Descriptors: *Colorado, *Erosion, *Geomorphology, *Gully erosion, *Headwaters hydrology, *Land reclamation, *Strip mines, Coal mining effects, Drainage basins, Valleys.

Surface-coal mining and reclamation in northwestern Colorado has caused substantial changes in geology, pedology, vegetation, hydrology, and geomorphology of many drainage basins. These changes have increased the potential for gully ero-

sion on reclaimed valley floors. Gullies on some reclaimed valley floors may be affected by geomorphic variables that can be manipulated during reclamation. Valley-floor erosion in several reclaimed drainage basins is related to three geomorphic variables: drainage area, valley gradient, and valley-floor width. The product of drainage area and valley gradient defines the area-gradient index, which is an indicator of potential valley-floor shear stress. Unstable valley floors were associated with larger area-gradient indicies than were stable valley floors. Clustering of data from stable and unstable valley-floor reaches and the relation between valley-floor width and the area-gradient index defined valley-erosion threshold. Reclaimed valley floors that had valley-floor width less than the threshold were more likely to be gullied than valley floors that had widths greater than the threshold. Geomorphic thresholds may be useful as planning tools in future reclamation projects. (See also W90-08822) (Author's abstract)
W90-08865

CONSTRUCTION AND CALIBRATION OF A RAINFALL SIMULATOR.
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).
For primary bibliographic entry see Field 2B.
W90-08903

RELATIVE IMPORTANCE OF FACTORS INFLUENCING FLUVIAL SOIL LOSS AT THE GLOBAL SCALE.
East Carolina Univ., Greenville, NC. Dept. of Geography and Planning.
J. D. Phillips.
American Journal of Science AJSCAP, Vol. 290, No. 5, p 547-568, May 1990. 3 tab, 54 ref.

Descriptors: *Climates, *Denudation, *Erosion, *Mathematical models, *Soil erosion, *Topography, Infiltration, Precipitation, Runoff, Sediment yield, Shear strength, Slope gradient, Soil texture, Spatial variation.

Soil loss is usually assessed at the field scale by considering climatic, topographic, hydrologic, soil erodibility, and surface cover factors. Global-scale variations in soil loss or denudation, as indicated by sediment yield, have been explained in terms of variation in climatic and relief factors. The study integrates field-scale and global erosion assessments to determine the relative importance of the factors that influence soil loss or erosion risks. Soil loss is assessed at the global scale by considering the maximum expected variation (MEV) in erosion rates between hypothetical extremes. A physical model based on stream power was used to assess the contribution of precipitation, slope gradient, slope length, runoff production, soil erodibility, and surface roughness factors to the maximum likely variation in soil loss rates. The slope gradient, runoff, and precipitation factors together account for about 99% of MEV (roughly 70, 15, and 14%, respectively). Soil shear strength (physical resistance), surface roughness, and slope length each accounts for less than 0.5%. The complex local spatial pattern of variation of infiltration and other factors influencing runoff has likely caused its effects to be obscured in previous regional and continental comparisons of denudation rates. Local-scale variation in relief is believed to have caused the importance of this factor to be underestimated in studies based on river sediments yields. (Author's abstract)
W90-08932

LANDSCAPE ASSESSMENT OF SOIL EROSION AND NONPOINT SOURCE POLLUTION.
Minnesota Univ., St. Paul. Dept. of Agricultural Engineering.
I. D. Moore, and J. L. Nieber.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 18-25, Fall 1989. 6 fig, 23 ref.

Descriptors: *Digital map data, *Geomorphology, *Nonpoint pollution sources, *Soil erosion, *Ter-

Group 2J—Erosion and Sedimentation

rain analysis, *Topography, Erosion, Rainfall-runoff relationships, Storm runoff.

Many hydrologic and water quality processes active in the landscape are dependent upon landscape position and a variety of topographic attributes, including local slope, aspect, specific drainage area, drainage distance, and plan and profile curvature. Compound topographic-based indices that are combinations of these primary attributes are capable of mapping the susceptibility of landscapes to erosion and nonpoint source pollution by determining zones of high soil water content in the landscape, areas where water flowing over the land surface concentrates and disperses, and the erosive power of flowing water. Spatially variable topographic-based attributes permit the distribution of hydrologic and nonpoint source pollution processes to be mapped within catchments. A 9.93 ha study area consisting of two adjacent catchments was evaluated using topographic indices. The indices were derived from Digital Elevation Models (DEMs) using a variety of Terrain Analysis Methods (TAMs). The analysis demonstrated that several hydrological, erosional, and nonpoint source pollution processes active in the study area were physically related to the topographic indices derived from the DEM. Local-point methods are the simplest and easiest TAMs to use. When the DEMs currently under development by the United States Geological Survey become widely available the procedure of using the topographic indices to evaluate the erosion and pollution potential of many areas will be possible. (Tappert-PTT)
W90-08972

ANALYSES OF STABILITY OF THE BAR CHANNEL OF FANGCHENG HARBOR (IN CHINESE).
Academia Sinica, Qingdao (China). Inst. of Oceanology.
For primary bibliographic entry see Field 2L.
W90-09025

GEOCHEMISTRY OF FE, MN, CA, MG IN SEDIMENTS AND INTERSTITIAL WATER OF THE FERROMANGANESE NODULE ENRICHMENT AREA FROM NORTH PACIFIC (IN CHINESE).
National Bureau of Oceanography, Hangzhou (China). Second Inst. of Oceanography.
G. Bao.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 20, No. 3, p 263-273, 1989. 7 fig, 3 tab, 15 ref. English summary.

Descriptors: *Ferromanganese nodules, *Geochemistry, *Interstitial water, *Manganese nodules, *Marine resources, *Pacific Ocean, *Sediment chemistry, Calcium, Iron, Magnesium, Manganese, Mineralization, Precipitation.

Geochemistry of Fe, Mn, Ca, and Mg in sediments and interstitial water are described based on data obtained during the first ferromanganese nodule survey in the North Pacific region (167 deg 00.06 min-178 deg 3.58 min W, 6 deg 57.16 min-10 deg 38.69 min N). The average contents of Fe, Mn, Ca, and Mg in the surface sediments are 3.02%, 0.60%, 18.87%, and 1.43%, respectively. Mn content is obviously higher than that in sediments of estuary and continental shelf, but Fe content is similar to that in the estuary. The average contents of $Fe(2+)$, $Mn(2+)$, $Ca(2+)$, and $Mg(2+)$ in interstitial water are 5.44 microgram /kg, 117.7 ug/kg, 403.1 microg/g, and 1169.3 microg/g, respectively. $Fe(2+)$ content is obviously higher than that in the estuary interstitial water and continental shelf, but $Mn(2+)$, $Ca(2+)$, and $Mg(2+)$ contents are similar to those in the continental shelf. In the calc-siliceous ooze region, $Fe(2+)$ and $Mn(2+)$ in interstitial water came mainly from the reduction of iron $(Fe(3+))$ and manganese $(Mn(3+))$ in sediments through the decomposing reaction of organic carbon mediated by bacteria. Thus, $Fe(2+)$ and $Mn(2+)$ in the 5-10 cm sediments are diffused toward the overlying water, resulting in a decrease in their contents. The low $Mg(2+)$ content in surface (0-5 cm) interstitial water is due to (1) the reduction of organic carbon by the decomposing

action of organic material in the sediments and (2) the replacement of $Fe(2+)$ by $Mn(2+)$ in the clay minerals and the formation of dolomite $(CaMg(CO3)2)$ and plaster stone $(CaSO4.2H2O)$ in the sediment. In the brown ooze zone, Fe and Mn in sediments and interstitial water decrease with the increase of sediment layer. Fe and Mg in the sediments of the studied area came mainly from adsorption of clay minerals; Mn in sediments came mainly from the movement of $Mn(2+)$ in surface sediments of the estuary and continental shelf and the biochemical action and volcanism in the oceanic environment. In the calc-siliceous ooze zone the $Mn(2+)/Fe(2+)$ ratio in interstitial water is higher and Mn/Fe ratio in sediments is smaller than in the calcareous and brown ooze zones, in good agreement with the higher abundance and faster growth rate of ferromanganese nodules in the calc-siliceous ooze zone, thus indicating a sedimentary origin of some main elements of the ferromanganese nodules. (Author's abstract)
W90-09026

SEDIMENTATION DYNAMICS IN THE SANTA MONICA-SAN PEDRO BASIN OFF LOS ANGELES: RADIOCHEMICAL, SEDIMENT TRAP AND TRANSMISSOMETER STUDIES.
Oregon State Univ., Corvallis. Coll. of Oceanography.
C. A. Huh, L. F. Small, S. Niemnil, B. P. Finney, and B. M. Hickey.
Continental Shelf Research CSHRDZ, Vol. 10, No. 2, p 137-164, February 1990. 12 fig, 3 tab, 28 ref.

Descriptors: *Lead radioisotopes, *Marine sediments, *Path of pollutants, *Radiochemical analysis, *Radioisotopes, *Sediment transport, *Sedimentation, California, Storm surges, Suspended sediments, Transparency, Turbidity currents.

A large number of sediment cores and sediment trap samples collected from different parts of the Santa Monica-San Pedro (SM-SP) Basin during 1985-1988 were studied for radionuclides, trace metals, and other sedimentary components to develop a basin-wide view of sedimentation dynamics. (210)Pb stratigraphy indicated that sedimentation rates were higher and more variable in the more dynamic slope region, but were uniformly low in the flat, deep basin. The sediment record suggests that sedimentation rates were decreasing and the area of anoxia had been expanding, at least during the past one to two centuries. Turbidite layers found in the sediment cores suggested higher frequency and more recent occurrence toward the basin margins. (210)Pb chronologies indicate that the recent turbidites might be related to storms which occurred during the past two decades. Sediment traps deployed in the basin recorded every large short-term spatial and temporal variabilities of mass flux, with unusually high fluxes corresponding to recorded large events. Results of trap-measured mass fluxes were consistent with (210)Pb-based sediment accumulation rates and strongly suggest lateral input of materials. Transmissometer data demonstrated the existence of nepheloid plumes off the eastern slope of the SM-SP basin. Based upon water column, sediment trap and sediment core data, self-consistent flux balances can be constructed for (228)Th and (210)Pb. Flux balances for Th234 were less well-defined. The cyclic pattern of uranium profiles in deep basin sediments appeared to be in phase with the sedimentary record of CaCO3 and the historical record of primary production and anchovy biomass. It is suggested that the removal of uranium from the water might be regulated by long-term regional changes in biological processes and sedimentation environments. (Author's abstract)
W90-09035

BEHAVIOR OF TRACE METALS IN THE GEUM ESTUARY, KOREA.
Skidaway Inst. of Oceanography, Savannah, GA.
For primary bibliographic entry see Field 2L.
W90-09038

ATTEMPT TO EXPLAIN AND QUANTIFY FLUVIAL MORPHOLOGICAL PROCESSES

BEGINNING WITH THE REGIME THEORY (ESSAI D'EXPLICATION ET DE QUANTIFICATION DES MORPHOLOGIES FLUVIALES A PARTIR DE LA THEORIE DE REGIME).
M. Ramette.
Houille Blanche HOBLAB, Vol. 1990, No. 1, p 43-60, 1990. fig 8, 2 tab, 11 ref. English summary.

Descriptors: *Alluvial channels, *Channel morphology, *Fluvial sediments, *Geomorphology, *Regime channels, *River beds, *Sediment transport, Bangladesh, Discharge measurement, Irrigation water, Mathematical analysis, Mathematical equations, River flow, Suspended solids, Theoretical analysis.

The most elementary feature of a river's morphology is a straight single bed. The mean geometrical characteristics of such a bed: depth, width, slope, have been the subject of numerous experimental studies to support the design of man-made stable channels. Mainly for irrigation purposes, Lacey developed a general theory of flow in alluvium channels which is known as the 'Regime theory'. The objective of the present article is to show that most of the morphological features (single meandering beds, straight and meandering braided beds) probably arise from an initial single straight bed under the 'regime theory' laws, when solid discharge gradually decreases. The theoretical relations deriving from the hypothesis presented are compared with the ones compiled from experimental results and especially from Jamuna river field measurements in Bangladesh. (Author's abstract)
W90-09057

SCALE MODEL OF THE LEAZ SLIPPAGE IN THE GENISSIAT RESERVOIR (ETUDE SUR MODELE REDUIT DU GLISSEMENT DE LEAZ DANS LA RETENUE DE GENISSIAT).
Compagnie Nationale du Rhone, Lyon (France).
For primary bibliographic entry see Field 8A.
W90-09058

EXAMINATION OF RUNOFF AND LOSS OF SOIL IN FIELD EXPERIMENTS WITH SPECIAL REFERENCE TO PRECIPITATION.
Lajos Kossuth Univ., Debrecen (Hungary). Inst. of Geography.
For primary bibliographic entry see Field 2A.
W90-09095

CLASSIFICATION OF LAKE BASINS AND LACUSTRINE DEPOSITS OF ESTONIA.
Akademiya Nauk Estonskoi SSR, Tallinn. Inst. Geologii.
For primary bibliographic entry see Field 2H.
W90-09124

FRACTAL INTERPRETATION OF THE MAINSTREAM LENGTH-DRAINAGE AREA RELATIONSHIP.
Montreal Univ. (Quebec). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W90-09158

COMPARISON OF NUMERICAL SCHEMES FOR SOLVING A SPHERICAL PARTICLE DIFFUSION EQUATION.
Environmental Research Lab., Athens, GA.
For primary bibliographic entry see Field 5B.
W90-09159

CHARACTERISTICS OF SELF-FORMED STRAIGHT CHANNELS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-09192

DISPERSAL OF SUSPENDED MATTER IN MAKASAR STRAIT AND THE FLORES BASIN.
Nederlands Inst. voor Onderzoek der Zee, Texel.
For primary bibliographic entry see Field 2L.
W90-09200

TEMPORAL VARIATIONS IN BEDLOAD TRANSPORT RATES ASSOCIATED WITH THE MIGRATION OF BEDFORMS.
Geological Survey, Denver, CO.
B. Gomez, R. L. Naff, and D. W. Hubbell.
Earth Surface Processes and Landforms ESPLDB, Vol. 14, p 135-156, 1989. 14 fig, 3 tab, 87 ref, append.

Descriptors: *Bed load, *Channel morphology, *Data interpretation, *Monte Carlo method, *Sediment distribution, *Sediment transport, *Statistical analysis, Comparison studies, Probability distribution, Temporal distribution.

Temporal variations in bedload transport rates that occur at a variety of timescales, even under steady flow conditions, are accepted as an inherent component of the bedload transport process. Rarely, however, has the cause of such variations been explained clearly. Three data sets, obtained from laboratory experiments, that refer to measurements of bedload transport made with continuously recording bedload traps were analyzed. Each data set is characterized by a predominant low-frequency oscillation, on which additional higher-frequency oscillations generally are superimposed. The period of these oscillations, as isolated through the use of spectral analysis, ranged between 0.47 and 168 minutes, and was associated unequivocally with the migration of bedforms such as ripples, dunes, and bars. The extent to which such oscillatory behavior may be recognized in a data set depends on the duration of sampling and the length of the sampling time, with respect to the period of a given bedform. Several theoretical probability distribution functions have been developed to describe the frequency distributions of (relative) bedload transport rates that are associated with the migration of bedforms. These distribution functions were derived without reference to a sampling interval. Hamamori's probability distribution function was modified, generated by Monte Carlo simulation, which permits the sampling interval to be specified in relation to the length of the bedform. Comparisons between the simulated and observed frequency distributions are good (significant at the 90% confidence level). Short-term temporal variations in bedload transport rates that are associated with the passage of bedforms are an inherent component of the bedload transport process. However, the extent to which the variations may be identified in any given record will depend upon the duration and frequency of sampling and the length of the sampling time, with respect to the period of the bedform(s) in question, and their transverse dimension(s) with respect to the degree to which the data reflect measurements that have been integrated across the cross-section. (Author's abstract)
W90-09206

SIMULATION OF THE DIAGENESIS OF CARBON, SULFUR, AND DISSOLVED OXYGEN IN SALT MARSH SEDIMENTS.
South Carolina Univ., Columbia. Belle W. Baruch Inst. for Marine Biology and Coastal Research.
L. R. Gardner.
Ecological Monographs ECMOAQ, Vol. 60, No. 1, p 91-111, March 1990. 12 fig, 2 tab, 56 ref, append.

Descriptors: *Diagenesis, *Marsh sediments, *Mathematical models, *Model studies, *Salt marshes, *Sediment chemistry, *Sulfur, Aeration, Carbon, Carbon isotopes, Dissolved oxygen, Organic matter, Pyrite, Sensitivity analysis, Simulation analysis.

A steady-state numerical model was developed for simulating vertical profiles of the concentrations of organic matter, pyritic sulfur, dissolved oxygen, and the carbon isotope composition of organic matter in marsh sediments. In the model, organic matter enters the sediment via sedimentation, belowground production of roots, and chemoautotrophic fixation of interstitial carbon dioxide associated with pyrite oxidation. Pyrite is formed by sulfate reduction and consumed by oxidation with dissolved oxygen in the interstitial water. Exchanges of organic matter, carbon isotopes, pyrite, and dissolved oxygen between the sediment and surface environment occur via fiddler crab biotur-

bation. Aeration of the sediment is caused by diffusion of oxygen into the interstitial water from air cavities assumed to be present in roots and in desaturated sediment pores formed in the upper part of the sediment by drainage and/or evapotranspiration. Sensitivity experiments with the model suggest that the accumulation of pyrite and organic matter in marsh sediments is governed in large part by the turnover time of roots and by the mean diameter of roots. The isotopic composition of the sediment was most sensitive to the rate of belowground production and to a lesser extent to the intensity of fiddler crab bioturbation. The model also indicated that fiddle crab burrowing can account for the observed isotope composition of creekbed sediments but not back (mid) marsh sediment. In both back and creekbank marshes, intense aeration of the sediment by roots is required to prevent the buildup of pyrite to unrealistically high concentrations at depth. (Author's abstract)
W90-09208

TRANSPORT AND STORAGE OF 137CS AND 210PB IN SEDIMENTS OF LAKE ST. CLAIR.
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 5B.
W90-09237

STORAGE AND DYNAMICS OF SUBSURFACE DETRITUS IN A SAND-BOTTOMED STREAM.
Virginia Commonwealth Univ., Richmond. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-09238

EFFECTS OF FLUCTUATING LEVELS OF LAKE SUPERIOR ON MORPHOLOGICAL ADJUSTMENTS IN THE NEEBING-MCINTYRE FLOODWAY, THUNDER BAY, ONTARIO, CANADA.
Lakehead Univ., Thunder Bay (Ontario). Dept. of Geography.
H. Rasid, and B. A. M. Phillips.
Regulated Rivers Research & Management RRRMEP, Vol. 5, No. 2, p 111-127, March/May 1990. 7 fig, 6 tab, 19 ref.

Descriptors: *Bank erosion, *Canada, *Channel morphology, *Erosion rates, *Flood control, *Floodways, *Geomorphology, *Lake Superior, *Sediment erosion, Flooding, McIntyre River, Neebing River, Ontario, River flow, Sediment-carrying capacity, Water level, Wind waves.

The Neebing-McIntyre Floodway, a relatively straight, trapezoidal flood-control channel, was constructed in 1983 to dispose of the combined flows of the Neeging and the McIntyre rivers into Lake Superior. Because of its location in a transitional fluvial/lacustrine environment, related processes had direct and indirect impacts on its morphological readjustments. During the post-construction period (1983-1988) the combined peak flows of the Neebing and the McIntyre Rivers never exceeded the two-year design floods for the floodway, resulting in relatively low stream power and sediment transport rates. The average rate of sedimentation in the new channel (1100 cubic m/ year) was thus much lower than the designers' estimated volume (11,800 cubic m/year). These low-flow events coincided with high water levels in Lake Superior in 1985-1986, reinforcing the normal backwater effect in the floodway and further dampening its stream power. During this event the floodway behaved hydraulically almost like a reservoir, with fluctuating water levels and wind-generated waves as the principal geomorphological agents of bank erosion. Estimates based on volumetric surveys indicate annual rates of bank erosion ranging from 0.03 to 0.16 cubic m/m of bank length, with an average annual rate of 0.1 cubic m/m. The bank materials are composed of highly erodible sandy loam and loamy sand, which have a tendency to disperse and liquefy relatively easily. There are no significant spatial variations in erosion rates along a given bank but contrasts in the magnitude of erosion between the north and the south banks can be related to the relative

exposure of a bank to average wind velocities, total duration of winds and the effective wind-wave fetches. (Author's abstract)
W90-09249

INTERACTIONS BETWEEN GEOMORPHOLOGICAL PROCESSES, BENTHIC AND HYPORHEIC COMMUNITIES: FIRST RESULTS ON A BY-PASSED CANAL OF THE FRENCH UPPER RHONE RIVER.
Lyon-1 Univ., Villeurbanne (France). Lab. d'Hydrobiologie et Ecologie Souterraines.
For primary bibliographic entry see Field 2H.
W90-09251

STUDIES ON SEDIMENTARY PHOSPHATE IN RECENT SEDIMENTS OF THE ZHUJIANG RIVER ESTUARY.
Academia Sinica, Qingdao (China). Inst. of Oceanology.
For primary bibliographic entry see Field 2L.
W90-09331

REELFOOT LAKE SEDIMENTATION RATES AND SOURCES.
Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.
S. C. McIntyre, and J. W. Naney.
Water Resources Bulletin WARBAQ, Vol. 26, No. 2, p 227-232, April 1990. 4 fig, 4 tab, 6 ref.

Descriptors: *Agricultural watersheds, *Erosion, *Lake sediments, *Recreation, *Sedimentation rates, Channeling, Erosion control, Land use, Radioactive tracers, Reelfoot Lake, Streams, Tennessee, Tracers.

The three basins of Reelfoot Lake, which is located in northwestern Tennessee, were investigated using the Cs-137 tracer technique to determine rates of sediment deposition and to estimate the time before the basins will fill with sediment. Blue Basin, the largest of the three basins with 2922 ha, had an average annual sedimentation rate of 0.9 cm/yr from 1954 to 1984. The basin will become too shallow for most boating and recreational activities in about 200 years. Buck Basin, the central basin with 774 ha, had an average annual sedimentation rate of 1.1 cm/yr and will become too shallow for most recreational uses in about 100 years. Upper Blue Basin, the most upstream and smallest basin with 439 ha, had an average annual sedimentation rate of 1.7 cm/yr and will become too shallow for most recreational uses in about 60 years. Two important sources of sediment to Reelfoot Lake are erosion from a large number of soybean fields and channelization of many of the streams that flow into the lake. Changes in land management that would reduce erosion could increase the time the lake would remain usable for recreational activities. (Author's abstract)
W90-09346

2K. Chemical Processes

ENZYMIC AND CHEMICAL ANALYSIS OF PARTICULATE ORGANIC MATTER FROM A BOREAL RIVER.
Clarkson Univ., Potsdam, NY. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-08703

PHOSPHORUS TRANSFORMATIONS IN THE EPILIMNION OF HUMIC LAKES: BIOLOGICAL UPTAKE OF PHOSPHATE.
Lancaster Univ. (England). Div. of Biological Sciences.
For primary bibliographic entry see Field 2H.
W90-08705

INTRACELLULAR NH4(+) AND NO3(-) ION POOLS ASSOCIATED WITH DEPOSITED PHYTOPLANKTON IN A MARINE SEDIMENT (AARHUS BIGHT, DENMARK).
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.

Group 2K—Chemical Processes

For primary bibliographic entry see Field 2L.
W90-08742

STUDY OF WATER REPELLENCY AND ITS AMELIORATION IN A YELLOW-BROWN SAND. 1. SEVERITY OF WATER REPELLENCY AND THE EFFECTS OF WETTING AND ABRASION.
Massey Univ., Palmerston North (New Zealand). Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W90-08911

STUDY OF WATER REPELLENCY AND ITS AMELIORATION IN A YELLOW-BROWN SAND. 2. USE OF SOME WETTING AGENTS AND THEIR INTERACTION WITH SOME ASPECTS OF IRRIGATION.
Massey Univ., Palmerston North (New Zealand). Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W90-08912

SPRINGS OF VIRGINIA REVISITED: A COMPARATIVE ANALYSIS OF THE CURRENT AND HISTORICAL WATER-QUALITY DATA.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Water Resources Research Center.
For primary bibliographic entry see Field 2F.
W90-08918

ACIDIFICATION AND RECOVERY OF SPODOSOL BS HORIZON FROM ACIDIC DEPOSITION.
Syracuse Univ., NY. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5C.
W90-08945

ESTIMATION OF FIELD SCALE LEACHING RATES FROM CHLORIDE MASS BALANCE AND ELECTROMAGNETIC INDUCTION MEASUREMENTS.
New South Wales Dept. of Agriculture, Deniliquin (Australia).
P. G. Slavich, and J. Yang.
Irrigation Science IRSCD2, Vol. 11, No. 1, p 7-14, 1990. 7 fig, 6 tab, 7 ref.

Descriptors: *Chlorides, *Leaching, *Mass balance, Electromagnetic induction, Irrigation, Mathematical models, Measuring instruments, Performance evaluation.

A mass balance model was developed to determine leaching rates from changes in the chloride profile is developed. The model, based on that of Rose and others described in 1979, accommodates realistic patterns of change in the shape of the chloride profile and for processes which result in reducing leaching efficiency. Field application of the model found that the average leaching rate calculated using water balance agreed closely with that calculated using the model. Leaching rates calculated from a field study were related to changes in electromagnetic induction measurements (EM-38 instrument). This enabled a field-scale leaching rate to be calculated from spatially averaged EM-38 measurements. Spatial variation was a major factor limiting field assessment of leaching rates using the chloride mass balance approach. The use of EM provides a rapid method of quantifying field variability. The mass balance model enables changes in EM readings to be interpreted in terms of leaching rate. Further work is required to develop simple techniques for obtaining field-scale estimates of bypass flow, possibly using whole-bay water balance and infiltration characteristics. (Rochester-PTT)
W90-08950

MERCURY IN FISH FROM NORTHEASTERN MINNESOTA LAKES: HISTORICAL TRENDS, ENVIRONMENTAL CORRELATES, AND POTENTIAL SOURCES.
For primary bibliographic entry see Field 5B.
W90-08985

THERMAL AND MINERAL SPRINGS AROUND THE SOUTHERN HIGHWAY, REGIONS X-XI, CHILE (FUENTES TERMALES Y MINERALES EN TORNO A LA CARRETERA AUSTRAL, REGIONES X-XI, CHILE).
Servicio Nacional de Geologia y Mineria, Santiago (Chile).
For primary bibliographic entry see Field 2F.
W90-08996

GEOCHEMISTRY OF FE, MN, CA, MG IN SEDIMENTS AND INTERSTITIAL WATER OF THE FERROMANGANESE NODULE ENRICHMENT AREA FROM NORTH PACIFIC (IN CHINESE).
National Bureau of Oceanography, Hangzhou (China). Second Inst. of Oceanography.
For primary bibliographic entry see Field 2J.
W90-09026

EXPERIMENTAL-ANALYTICAL METHOD OF MODELLING TRANSFORMATION OF NATURAL ORGANIC MATTER IN WATER STORAGE RESERVOIRS.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2H.
W90-09030

BEHAVIOR OF TRACE METALS IN THE GEUM ESTUARY, KOREA.
Skidaway Inst. of Oceanography, Savannah, GA.
For primary bibliographic entry see Field 2L.
W90-09038

CHEMICAL MECHANISMS IN THE DISSOLUTION KINETICS OF MINERALS; THE ASPECT OF ACTIVE SITES.
Eidgenoessische Technische Hochschule, Zurich (Switzerland).
B. Wehrli, E. Wieland, and G. Furrer.
Aquatic Sciences AQSCEA, Vol. 52, No. 1, p 3-31, 1990. 9 fig, 5 tab, 68 ref.

Descriptors: *Dissolved solids, *Geochemistry, *Kinetics, *Minerals, *Soil chemistry, *Water chemistry, *Weathering, Active sites, Kaolinite, Surface structure, Trace metals, Water pollution sources.

Many minerals in nature which contribute to the chemical composition of the hydrosphere and soils are not in equilibrium with the aqueous phase. Where surface and soil waters are undersaturated with respect to a distinct mineral phase, the dissolution kinetics of that solid is of major interest. Mechanistic rate laws for the description of mineral dissolution include (often implicitly) the mole fraction of active surface sites. The area of active sites is first estimated by dissolution experiments in the presence of polyvalent cations which inhibit proton-promoted dissolution. The dissolution reactivities of surface aluminum centers of several minerals and of comparable dissolved polynuclear aluminum complexes were determined. This comparison offers a second possibility for the indirect estimation of the concentration range of active surface sites. Thus, the coordination geometries of surface aluminum centers, which are given by the crystal lattice network, probably determine the reactivity in dissolution processes. (Author's abstract)
W90-09049

CHEMICAL ASPECTS OF IRON OXIDE COAGULATION IN WATER: LABORATORY STUDIES AND IMPLICATIONS FOR NATURAL SYSTEMS.
California Inst. of Tech., Pasadena. W.M. Keck Lab. of Environmental Engineering Science.
L. Liang, and J. J. Morgan.
Aquatic Sciences AQSCEA, Vol. 52, No. 1, p 32-55, 1990. 7 fig, 2 tab, 73 ref.

Descriptors: *Chemical coagulation, *Geochemistry, *Iron compounds, *Iron oxides, *Water chemistry, Adsorption-desorption, Colloids, Estuaries, Hydrogen ion concentration, Ions, Lakes, Model

studies, Natural waters, Organic acids, Particulate matter, Phosphates.

Initial coagulation rates of colloidal hematite (alpha-Fe_2O_3) particles (diameter less than 0.1 micrometers) were measured experimentally in well-defined laboratory systems at constant temperature. The relative stability ratio, W, was obtained at various ionic strengths in NaCl medium and at pH values in the range from 3 to 12. Experimental W values ranged from 1 to 10,000 in various systems. The results delineate the roles of specific and generalized coagulation mechanisms for iron oxides. Among the specifically-interacting species studied were phosphate, monomeric organic acids of various structures, and polymeric organic acids. The critical coagulation-restabilization concentrations of specifically-interacting anions can be compared with the general effects of non-specific electrolyte coagulants. The laboratory results are interpreted with the help of a Surface Complex Formation/Diffuse Layer Model which describes variations of interfacial charge and potential resulting from variations of coagulating species in solution. Comparison of these laboratory experiments with observations on iron behavior in estuarine and lake waters aids in understanding iron removal mechanisms and coagulation time scales in natural systems. (Author's abstract)
W90-09050

BIOGEOCHEMISTRY OF IRON IN AN ACIDIC LAKE.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 2H.
W90-09051

INTERACTION OF TRACE METALS WITH NATURAL PARTICLE SURFACES: COMPARISON BETWEEN ADSORPTION EXPERIMENTS AND FIELD MEASUREMENTS.
Eidgenoessische Technische Hochschule, Zurich (Switzerland).
For primary bibliographic entry see Field 5B.
W90-09052

STUDY OF INORGANIC LIGAND-CHROMIUM(III)-SURFACE TERNARY COMPLEXES BY ESR SPECTROSCOPY.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland). Inst. of Aquatic Sciences.
L. Charlet, and R. Karthein.
Aquatic Sciences AQSCEA, Vol. 52, No. 1, p 93-102, 1990. 4 fig, 2 tab, 31 ref.

Descriptors: *Adsorption, *Chromium, *Laboratory methods, *Metal complexes, *Spectroscopy, *Trace metals, Water chemistry, Electron spin resonance, Fluorides, Phosphates, Selenates, Selenites, Sulfates.

Adsorption by solid surfaces has long been considered an important mechanism for controlling trace metal concentrations in natural waters. The change of the Cr(III) ligand environment upon complexation with various inorganic anions was investigated both in the liquid phase and at the liquid/solid interface. For a given pH and anion concentration, electron spin resonance (ESR) spectra were recorded with four different systems: Cr, Cr and anion, Cr and surface, Cr with anion and surface together. The ESR spectra of the surface obtained in the presence of selenite, phosphate and fluoride can be explained in terms of ternary surface complex formation. This is contrasted by the behavior of sulfate and selenate ions which were found to have no effect on the ligand field of Cr(III), either in the adsorbed state or in solution. (Creskoff-PTT)
W90-09053

AMMONIA NITROGEN IN THE BLACK SEA (IN RUSSIAN).
For primary bibliographic entry see Field 5B.
W90-09060

DISSOLVED MANGANESE IN THE NORTH-EASTERN ATLANTIC OCEAN (IN RUSSIAN).
V. V. Gordeev, and V. B. Atnashev.
Okeanologiia OKNOAR, Vol. 30, No. 1, p 64-69, 1990. 3 fig, 25 ref.

Descriptors: *Manganese, *Oceanography, *Sea-water, *Solute transport, *Trace metals, Advection, Africa, Atlantic Ocean, Continental shelf, Continental slope, Diffusion, Dusts, Marine sediments, Residence time, Sediment discharge, Water analysis, Water pollution sources.

Dissolved manganese was determined in the surface waters of the latitudinal transect at 26 degrees N and the submeridional transect from polygon TAG (26 degrees N) up to Biscay Bay and also on vertical profiles at stations of the polygon during the 15th cruise of the Research Vessel 'Academik Mstislav Kedysh' in the North Atlantic in April-May of 1988. On both transects, the dissolved manganese concentration increased from the central part of the ocean to the continents. This elevation was due to the influence of the flow of eolian dust from Africa in the open ocean and the important role of river input and advection and diffusion of manganese from shelf and slope sediments near the continents. The residence time of dissolved manganese in the surface mixed layer of water in the northeastern part of the ocean is about 6 years. (Author's abstract)
W90-09061

ORGANIC CARBON AND FORMATION OF ORGANIC MATTER IN GULFS OF THE WHITE SEA (IN RUSSIAN).
M. P. Maksimova, and S. S. Vladimirskii.
Okeanologiia OKNOAR, Vol. 30, No. 1, p 78-85, 1990. 1 fig, 2 tab, 8 ref. English summary.

Descriptors: *Coastal waters, *Dissolved organic carbon, *Dissolved solids, *Nutrient concentrations, *Nutrient transport, *Organic matter, *Seawater, *White Sea, Bays, Primary productivity, Salinity, Stream discharge, USSR, Water analysis, Water depth, Water pollution sources.

The organic carbon of the White Sea was first investigated in the summer of 1987. Studies were carried out in different parts of Kandalaksha and Onega Bays. Organic carbon content was in the range 3.5-9 mg C/L. The highest concentration was observed in shallow bays in the southern part of Onega Bay--the Sumskaya Gulf (6.17 mg C/L) and the Kolezhma Gulf (5.25. mg C/L); a somewhat lower concentration of organic carbon was observed in the Sorokskaya Gulf (4.85 mg C/L) and the Kemskaya Gulf (4.78 mg C/L); and the lowest concentration was observed in the deep-water bays of Kandalaksha Bay--the Chupa Gulf (4.35 mg C/L) and the Great Salma Gulf (4.10 mg C/L). In the deep-water bays, organic carbon decreased with depth. The main role in the formation of organic matter in the waters of Onega Bay, influenced by river inflows, is attributed to allochthonous organic matter of terrigenous origin. This is supported by the negative relationship between organic carbon distribution and salinity and by the insignificant relation between carbon and primary productivity. (Author's abstract)
W90-09062

CHEMICAL COMPOSITION OF INTERCEPTED CLOUDWATER IN THE SIERRA NEVADA.
California Inst. of Tech., Pasadena. W.M. Keck Lab. of Environmental Engineering Science.
For primary bibliographic entry see Field 5B.
W90-09115

MERCURY CONTENT OF ANTARCTIC SURFACE SNOW: INITIAL RESULTS.
Department of Scientific and Industrial Research, Petone (New Zealand). Chemistry Div.
For primary bibliographic entry see Field 2C.
W90-09116

SURVEY OF MICROBIAL POPULATIONS IN BURIED-VALLEY AQUIFER SEDIMENTS FROM NORTHEASTERN KANSAS.

NSI Technology Services Corp., Ada, OK.
For primary bibliographic entry see Field 2F.
W90-09137

CAUSES OF SOIL SALINIZATION: I. A BASIN IN SOUTHERN ALBERTA, CANADA.
Alberta Agriculture, Lethbridge.
M. J. Hendry, and G. D. Buckland.
Ground Water GRWAAP, Vol. 28, No. 3, p 385-393, May/June 1990. 10 fig, 1 tab, 27 ref.

Descriptors: *Geochemistry, *Groundwater recharge, *Model studies, *Path of pollutants, *Saline soils, *Salinization, *Soil contamination, Canada, Hydraulic conductivity, Hydraulic head, Leaching, Salinity.

The cause of soil salinization affecting 1700 ha of a basin in southern Alberta, Canada was examined. Water-table data indicate that groundwater recharges over a large diffuse area to the south of the salinized lands. Hydraulic head and hydraulic conductivity data and stream function modeling show that the recharging groundwater travels laterally towards the salinized area in shallow, permeable beds of the Foremost Formation. The presence of an angular unconformity between the shallow, flat-lying bedrock and the overlying Quaternary deposits causes the groundwater to discharge at the salinized area. Calculated discharge rate to the salinized area ranges from 2 to 40 mm/yr. (Author's abstract)
W90-09139

MECHANISMS CONTROLLING THE CHEMICAL COMPOSITION OF LAKES AND RIVERS: DATA FROM AFRICA.
Michigan Univ., Ann Arbor. Dept. of Biology.
P. Kilham.
Limnology and Oceanography LIOCAH, Vol. 35, No. 1, p 80-83, January 1990. 3 fig, 24 ref.

Descriptors: *Africa, *Calcium carbonate, *Evaporation, *Geochemistry, *Lakes, *Rivers, *Springs, *Water chemistry, *Weathering, Chemical properties, Chlorides, Connate water, Leaching, Natural waters, Salinity, Salts, Sulfates.

Water analyses for 424 lakes, rivers, and springs throughout intertropical Africa indicate that the chemical compositions of these waters are controlled primarily by rock dominance (weathering reactions) and the evaporation-crystallization process (evaporative concentration and calcite precipitation). There are minor deviations from the primary pattern observed in Africa and elsewhere. These deviations usually occur as a result of contamination by cyclic salts or salts ultimately derived from ancient lacustrine deposits or salts ultimately of marine origin which were transported by ocean-derived atmospheric precipitation, leached from rocks (connate waters) or dissolved from evaporite deposits. (Geiger-PTT)
W90-09146

TEMPERATURE EFFECTS ON SILICON AND PHOSPHORUS LIMITED GROWTH AND COMPETITIVE INTERACTIONS AMONG THREE DIATOMS.
Amsterdam Univ. (Netherlands). Dept. of Aquatic Ecology.
For primary bibliographic entry see Field 2H.
W90-09193

MODEL OF THE EXCHANGE OF INORGANIC CHEMICALS BETWEEN WATER AND SEDIMENTS.
Toronto Univ. (Ontario). Inst. for Environmental Studies.
For primary bibliographic entry see Field 5B.
W90-09220

SEASONAL CHANGES IN PORE WATER CONCENTRATIONS OF NUTRIENTS AND THEIR DIFFUSIVE FLUXES AT THE SEDIMENT-WATER INTERFACE.
Centre d'Etudes d'Oceanographie et de Biologie Marine, Roscoff (France).

Y. Lerat, P. Lasserre, and P. le Corre.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 135, No. 2, p 135-160, March 1990. 13 fig, 3 tab, 75 ref.

Descriptors: *Cycling nutrients, *Estuarine environment, *Nutrients, *Pore water, *Sediment chemistry, *Sediment-water interfaces, Ammonium, Bay of Morlaix, Degradation, Nitrates, Nitrites, Organic carbon, Organic nitrogen, Oysters, Seasonal variation, Silicates, Water chemistry, Water circulation.

Seasonal variations of dissolved NH4(+), NO3(-), NO2(-) and Si(OH)4 within an oyster bed sediment from the Bay of Morlaix, Brittany, France, were studied from February 1985 to January 1986. They were compared to the annual pattern of sedimentary organic C and N. Nutrient fluxes at the sediment-water interface were measured using sediment cores and compared to those estimated from solute gradients between pore water and the water column. Organic matter showed three accumulation periods. The highest one occurred during summer. Humic compounds analysis confirmed a marine origin while they displayed a terrigenous origin in January and April. Vertical profiles of organic matter are characteristic of a strong burial activity. Gradients between the first centimeter of the sediment and the water column ranged from 36.6 to 202.4 micromoles/L/cm for ammonium and -15.2 to 130.2 micromoles/L/cm for nitrate. Nitrite ranged from 0.8 to 9.2 micromoles/L/cm, and silicate ranged from -3.6 to 152.4 micromoles/L/cm. Whatever the organic matter source was, the degradation pattern in the sediment followed the same processes. Pore water NO3(-) profiles were greatly influenced by endofauna activity. These oxidation processes appeared slower than in the water column but organic and nutrient concentrations encountered were generally much higher. The annual pattern of the exchanges of the remineralized compounds Si(OH)4, NH4(+), NO3(-), and NO2(-) at the sediment-water interface was studied under laboratory conditions using a core incubation method. These nutrient fluxes ranged over the year from -24.8 to 47.7 micromoles/square m/hour for ammonium, from -15.6 to 94.1 micromoles/square m/hour for nitrate, from -10.8 to 9.3 micromoles/square m/hour for nitrite and from -18.9 to 94.5 micromoles/square m/hour for silicate. The annual variations of nitrate and nitrite fluxes have been found to be well correlated with the C:N ratio of the organic matter within the first centimeter of the sediment. (Mertz-PTT)
W90-09242

AMMONIUM, NITRATE, PHOSPHATE, AND INORGANIC CARBON UPTAKE IN AN OLIGOTROPHIC LAKE: SEASONAL VARIATIONS AMONG LIGHT RESPONSE VARIABLES.
Montana State Univ., Bozeman. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-09247

TRANSPORT OF MAJOR SOLUTES AND THE RELATIONSHIP BETWEEN SOLUTE CONCENTRATIONS AND DISCHARGE IN THE APURE RIVER, VENEZUELA.
Colorado Univ. at Boulder. Center for Limnology.
For primary bibliographic entry see Field 2E.
W90-09264

STRONTIUM ISOTOPE STUDIES OF ATMOSPHERIC INPUTS TO FORESTED WATERSHEDS IN NEW MEXICO.
New Mexico Univ., Albuquerque. Dept. of Biology.
J. R. Gosz, and D. I. Moore.
Biogeochemistry BIOGEP, Vol. 8, No. 2, p 115-134, September 1989. 2 fig, 7 tab, 12 ref.

Descriptors: *Atmospheric chemistry, *Environmental tracers, *Forest ecosystems, *Forest watersheds, *Isotope studies, *New Mexico, *Radiochemical analysis, *Strontium radioisotopes, *Tracers, Aerosols, Canopy, Plant tissues, Poplar trees, Precipitation, Spruce trees, Throughfall, Weathering.

Field 2—WATER CYCLE

Group 2K—Chemical Processes

Stable isotopes of strontium provide a unique quantification of ecosystem processes because organisms do not differentiate between them. For landscapes with contrasting geologies, these isotopes can identify atmospheric source material from local weathered material. This study quantified the input as strontium, distribution within the ecosystem, canopy capture versus leaf leachate, canopy loss, and Sr increment in biomass from an atmospheric origin. Forest ecosystems were studied along an elevational gradient in New Mexico. Spruce forests had a much greater capacity for capturing atmospheric Sr than aspen forests; however, aspen contained more total atmospheric Sr in their tissues because of greater uptake rates and the ability to utilize atmospheric deposited Sr before the initiation of the aspen forest. This technique has excellent capabilities for estimating the relative importance of atmospheric and weathering inputs to certain ecosystems. (Author's abstract)
W90-09265

COMPARISON OF NITRIFICATION RATES IN THREE BRANCHES OF THE LOWER RIVER RHINE.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5B.
W90-09266

SOIL N MINERALIZATION AND NITRIFICATION IN RELATION TO NITROGEN SOLUTION CHEMISTRY IN A SMALL FORESTED WATERSHED.
York Univ., North York (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2G.
W90-09268

GEOCHEMISTRY, AGE, AND ORIGIN OF GROUNDWATER IN A MAFIC PLUTON, EAST BULL LAKE, ONTARIO, CANADA.
Ottawa Univ. (Ontario). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-09291

RARE EARTH ELEMENTS IN RIVERS, ESTUARIES, AND COASTAL SEAS AND THEIR SIGNIFICANCE TO THE COMPOSITION OF OCEAN WATERS.
Cambridge Univ. (England). Dept. of Earth Sciences.
H. Elderfield, R. Upstill-Goddard, and E. R. Sholkovitz.
Geochimica et Cosmochimica Acta GCACAK, Vol. 54, No. 4, p 971-991, April 1990. 13 fig, 5 tab, 58 ref. NERC grant GST/02/24 and NSF grant OCE-85-15695.

Descriptors: *Cerium, *Chemical properties, *Estuaries, *Geochemistry, *Lanthanum, *Oceans, *Rare earth elements, *Rivers, *Water chemistry, Coastal waters, Connecticut Estuary, Delaware River Estuary, Gadolinium, Lutetium, Mullica Estuary, Natural waters, Salinity, Tamar Estuary, Water analysis, Water distribution.

The concentrations of the rare earth elements in samples from 15 rivers, from 6 estuarine transects and of 5 coastal seawaters are reported and have been used with literature data to examine the continuity in average rare earth element pattern between average continental crust and the dissolved input of rare earth elements to the oceans via estuaries. Rare earth element patterns, normalized to average shale, are of two main types: all show heavy rare earth element enrichment between La and Gd, but either heavy rare earth element enrichment or depletion between Gd and Lu. Some patterns show negative cerium anomalies, and these can be related to pH in a small suite of carbonate rivers. There are two main pools for the rare earth elements in rivers: a colloidal pool of rare earth element-rich particles <0.4 micrometers having a shale-like pattern, and a dissolved pool characterized by heavy rare earth element enrichment. Significant rare earth element removal during the mixing of river water and sea water was measured for the Connecticut, Delaware, Mullica

estuaries (USA) and, on two occasions, Tamar (UK) estuary. Removal varied from about 30% to near-quantitative. In some cases, preferential removal of the light rare earth element was observed, but this may be caused by coagulation of colloidally associated rare earth elements, changing the proportions of the two rare earth element pools. The rare earth element concentrations and patterns of the coastal seawaters are intermediate between those for rivers and for ocean waters, reflecting the influence of continental drainage. The dissolved input of rare earth elements to the oceans is characterized by rare earth element patterns in which the evolution of the characteristic oceanic rare earth element pattern has started to develop. The same fundamental processes that define the oceanic pattern appear to operate for continental waters also, but the rare earth element patterns are not as evolved (for example, fractionated relative to continental crust) because of lower pH and shorter water residence times. (Mertz-PTT)
W90-09292

GEOCHEMISTRY OF DISSOLVED PHOSPHATE IN THE SEPIK RIVER AND ESTUARY, PAPUA, NEW GUINEA.
Harvard Univ., Cambridge, MA. Dept. of Earth and Planetary Sciences.
L. E. Fox.
Geochimica et Cosmochimica Acta GCACAK, Vol. 54, No. 4, p 1019-1024, April 1990. 6 fig, 1 tab, 20 ref.

Descriptors: *Chemical properties, *Estuaries, *Iron, *Model studies, *New Guinea, *Phosphates, *Rivers, *Water chemistry, Oceans, Phosphorus, Saline water, Sepik River, Water currents.

The natural regulation of phosphate in the Sepik River and Estuary, Papua, New Guinea, was investigated by fitting field measurements to a chemical model. Results indicate that ferric iron and phosphate in the river and salinity to 12 parts per thousand in the estuary are primarily influenced by equilibration with a discrete amorophous solid phase. Dissolved ferric iron is saturated with respect to amorphous ferric hydroxide in the river and most of the estuary. Dissolved phosphorus is equilibrated with amorphous ferric hydroxide-phosphorus solid solution in river waters and the low salinity third of the plume. A modest input of phosphate, believed driven by disequilibrium, was observed at mid-estuary. Input is roughly equivalent to removal and is thought to be limited by a paucity of phosphorus in the solid phase. Oceanic fluxes of phosphorus from major Pacific Islands may not be large despite disproportionately large sediment fluxes, if other watersheds contain reservoirs of solid phosphorus as small as the Sepik River. (Author's abstract)
W90-09293

CHEMISTRY OF BORATE IN SALT LAKE BRINE VII. THE FORM OF BORATE EXISTING IN CONCENTRATED BRINE AND ITS EXPRESSION (IN CHINESE).
Qinghai Inst. of Salt Lake, Xining (China).
S. Gao, J. Wang, S. Xia, and Q. Shi.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 20, No. 5, p 429-437, September 1989. 2 fig, 3 tab, 13 ref. English summary.

Descriptors: *Borates, *Boron, *Brines, *Salt lakes, *Water chemistry, Evaporation, Titration.

The concentrated brine containing abundant borate and formed during spontaneous evaporation, and the form of borate existing in concentrated brine were studied using hydrochloric acid-pH titration. A pH titration curve was calculated and a qualitative analysis of the curve was made. It was concluded that the borate existing in the brine in a comprehensive statistical form of tetraborate, B4O7(OH)4(-2). During spontaneous evaporation of brine the mirabolite is generally dissolved, and the borate does not precipitate in a solid phase. The composition of each concentrated brine was measured and the salt-formation calculation made using a species paired equation. Based on the cal-

culations, in was concluded that the form of borate present in salt lake brine can be expressed as a comprehensive statistical form of tetraborate, such as magnesium tetraborate Mg0.2B203. (Author's abstract)
W90-09329

STUDIES ON SEDIMENTARY PHOSPHATE IN RECENT SEDIMENTS OF THE ZHUJIANG RIVER ESTUARY.
Academia Sinica, Qingdao (China). Inst. of Oceanology.
For primary bibliographic entry see Field 2L.
W90-09331

METALS SPECIATION, SEPARATION, AND RECOVERY. VOLUME II.
For primary bibliographic entry see Field 5B.
W90-09381

EFFECT OF SPECIATION ON THE RATES OF OXIDATION OF METALS.
Rosenstiel School of Marine and Atmospheric Science, Miami, FL.
F. J. Millero.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 125-141, 11 fig, 18 ref. Office of Naval Research Grant N00014-87-0116 and NSF Grant OCE86-00284.

Descriptors: *Chemical reactions, *Chemical speciation, *Metals, *Oxidation, *Path of pollutants, *Urban hydrology, Copper, Heavy metals, Iron, Kinetics, Manganese, Reduction.

Trace metals can participate in a wide range of chemical and biological reactions in industrial and natural waters. The speciation of metals in these waters is important because the different forms of many metals have different chemistries. For example, the biological toxicity and availability is strongly affected by the redox state and chemical form of a given metal. Copper, for example, is toxic to many marine organisms when it is in the free or uncomplexed state. Iron and manganese are needed by phytoplankton for growth. The oxidized forms of these metals are insoluble and are quickly scavenged from surface waters. Although thermodynamic speciation calculations can yield the most probable redox and complexed form of a given metal, the redox form is normally controlled by the rates of oxidation and reduction. Recent kinetic measurements have been made on the oxidation of Cu(I) and Fe(II) with O2 and H2O2 in natural waters. These studies have demonstrated that the formation of ion pairs can either accelerate or decrease the rates of oxidation. The formation of FeOH(+) and Fe(OH)2 accelerates the rate of oxidation of Fe(II); while the formation of CuCl, CuCl2 and CuCl3(2-) causes the rates of oxidation of Cu(I) to decrease. In this paper the manner in which the speciation of metals affects the rates of oxidation of metals and nonmetals is demonstrated, along with how these effects can be incorporated into the rate equations. (See also W90-09381) (Lantz-PTT)
W90-09387

SPECIATION OF ALUMINUM IN GEOTHERMAL BRINES: COMPARISON OF DIFFERENT METHODOLOGIES.
CISE S.p.A., Technologie Innovative, Segrate (MI), Italy.
M. Achilli, G. Ciceri, R. Ferraroli, G. Culivicchi, and S. Pieri.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 237-260, 6 fig, 13 tab, 22 ref.

Descriptors: *Aluminum, *Brines, *Chemical analysis, *Chemical reactions, *Chemical speciation, *Geothermal water, *Pollutant identification,

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*Urban hydrology, *Water analysis, Filtration, Heavy metals, Hydrogen ion concentration, Pyrocatechol violet, Resins, Water temperature.

A comparison of different methods for aluminum speciation in geothermal brines is reported and discussed with the view of the optimization of an accurate and easy, in-field operable procedure to separate monomeric from polymeric forms of the element. The tested methods involve complexation with pyrocatechol violet (PCV)(3,3',4'-trihydroxyfuchsone sulfonic acid), retention on strong cationic resin or inorganic exchangers beds, chelation with supported 8-hydroxyquinoline (8-HQ), filtration or ultrafiltration, solvent extraction. Some of the selected methods have been studied as a function of several parameters (Al concentration, flow rate, pH, temperature, brine composition, concentration of competitive binding agents). The results show the selectivity of PCV in complexing monomeric Al and the usefulness of supported 8-HQ to preconcentrate total Al from geothermal brines. The polymeric fraction can be quantitatively retained on a cationic resin if the monomeric forms are previously chelated with PCV. Neither filtration (0.01 microm) or ultrafiltration (10,000 dalton nominal weight cut-off) were able to separate monomeric from polymeric forms of Al. Emphasis is given to the preparation of Al standard solutions with defined monomer/polymer ratios. The stability of these solutions was studied as a function of aging, temperature and CO2 content. (See also W90-09381) (Author's abstract)
W90-09391

SPECIATION OF TIN IN SEDIMENTS OF ARCACHON BAY (FRANCE).
Universite de Pau et des Pays de l'Adour (France). Lab. de Chimie Analytique.
For primary bibliographic entry see Field 5B.
W90-09392

METAL COMPLEXATION BY WATER-SOLUBLE ORGANIC SUBSTANCES IN FOREST SOILS.
Vrije Univ., Amsterdam (Netherlands). Dept. of Ecology and Ecotoxicology.
For primary bibliographic entry see Field 5B.
W90-09393

THEORETICAL AND EXPERIMENTAL DRAWBACKS IN HEAVY METAL SPECIATION IN NATURAL WATERS.
Pisa Univ. (Italy). Dipt. di Chimica.
For primary bibliographic entry see Field 5C.
W90-09394

PROTON AND METAL ION BINDING ON HUMIC SUBSTANCES.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Plant Nutrition.
For primary bibliographic entry see Field 5B.
W90-09395

EFFECTS OF FOREST CANOPY ON THROUGHFALL PRECIPITATION CHEMISTRY.
Swiss Federal Inst. of Forestry Research, Birmensdorf.
For primary bibliographic entry see Field 5B.
W90-09431

LEACHING OF STRONG ACID ANIONS FROM SNOW DURING RAIN-ON-SNOW EVENTS: EVIDENCE FOR TWO COMPONENT MIXING.
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
For primary bibliographic entry see Field 5B.
W90-09435

2L. Estuaries

VARIATIONS OF HEAVY METALS AND ARSENIC IN FISH AND OTHER ORGANISMS FROM THE CALCASIEU RIVER AND LAKE, LOUISIANA.
McNeese State Univ., Lake Charles, LA. Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W90-08647

EFFECT OF TRIBUTYLTIN ON THE CHEMILUMINESCENT RESPONSE OF PHAGOCYTES FROM THREE SPECIES OF ESTUARINE FISH.
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 5C.
W90-08649

STUDY OF STEADY STATE AND KINETIC REGULATION OF CHLORIDE ION AND OSMOTIC PRESSURE IN HEMOLYMPH OF OYSTERS, CRASSOSTREA VIRGINICA, EXPOSED TO TRI-N-BUTYLTIN.
Yale Univ., New Haven, CT. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W90-08650

PARASITISM IN MARINE FISH AFTER CHRONIC EXPOSURE TO PETROLEUM HYDROCARBONS IN THE LABORATORY AND TO THE EXXON VALDEZ OIL SPILL.
Memorial Univ. of Newfoundland, St. John's. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W90-08658

EFFECTS OF CUCL2 ON THE GERMINATION RESPONSE OF TWO POPULATIONS OF THE SALTMARSH CORDGRASS, SPARTINA ALTERNIFLORA.
Felician Coll., Lodi, NJ.
For primary bibliographic entry see Field 5C.
W90-08659

ACUTE TOXICITY OF CADMIUM, COPPER, ZINC, AMMONIA, 3,3'-DICHLOROBENZIDINE, 2,6-DICHLORO-4-NITROANILINE, METHYLENE CHLORIDE, AND 2,4,6-TRICHLOROPHENOL TO JUVENILE GRASS SHRIMP AND KILLIFISH.
Johns Hopkins Univ., Silver Spring, MD. Applied Physics Lab.
For primary bibliographic entry see Field 5C.
W90-08660

LEAD AND CADMIUM CONCENTRATIONS IN MARINE ORGANISMS FROM THE TARRAGONA COASTAL WATERS, SPAIN.
Barcelona Univ., Tarragona (Spain). Lab. of Toxicology and Biochemistry.
For primary bibliographic entry see Field 5B.
W90-08661

CONCENTRATIONS OF SELECTED CHLORINATED PESTICIDES IN SHRIMP COLLECTED FROM THE CALCASIEU RIVER/LAKE COMPLEX, LOUISIANA.
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
For primary bibliographic entry see Field 5B.
W90-08663

MESOSCALE AND SEASONAL VARIABILITY OF HETEROTROPHIC NANOFLAGELLATE ABUNDANCE IN AN ESTUARINE OUTFLOW PLUME.
State Univ. of New York at Stony Brook. Marine Sciences Research Center.
G. B. McManus, and J. A. Fuhrman.
Marine Ecology Progress Series MESEDT, Vol. 61, No. 3, p 207-213, 1990. 6 fig, 2 tab, 39 ref. NSF grant OCE 8545037.

Descriptors: *Bacteria, *Chesapeake Bay, *Estuaries, *Flagellates, *Zooplankton, Abundance, Mixing conditions, Nanoflagellates, Salinity, Seasonal variation.

The abundance of heterotrophic nanoflagellates was measured in the estuarine outflow plume of the Chesapeake Bay during cruises in February, April, June, and August. Changes in abundance were measured during both surface mapping and drifter (time series) operations. Flagellate abundance varied as much within each cruise as across all cruises, and there was little evidence of a seasonal pattern. Abundance ranged from 10,000 to 100,000 cells/ml on all 4 cruises. Choanoflagellates were an important component of the flagellate community in winter (22% of total numbers), but were less important in other seasons (less than 10%). Modal flagellate size was greatest in February (4.5 microm equivalent spherical diameter) and least in August (2.5 micom). In general, flagellate abundance was several-fold higher within the plume, was negatively correlated with salinity, and declined over time as the plume mixed with surrounding coastal water. April was an exception, when downwelling-favorable winds and high freshwater discharge produced strong mixing conditions: in contrast to February, June, and August, there was no strong gradient in flagellate abundance between plume and coastal water. In June and August, size-fractionated microcosm experiments indicated that flagellate growth rates of 1/d were balanced by microzooplankton grazing. Thus, net population changes were driven by physical processes. Variations in the bacteria to flagellate biomass ratio, and analysis of relationships among bacterial, flagellate, and phytoplankton abundance, suggest that both substrate supply and grazing can be important controls on bacteria in the plume. (Author's abstract)
W90-08715

PELAGIC NUTRIENT AND ENERGY TRANSFER DURING SPRING IN THE OPEN AND COASTAL SKAGERRAK.
Kristenebergs Marinbiologiska Station, Fiskebackskil (Sweden).
R. Rosenberg, E. Dahl, L. Edler, L. Fyrberg, and E. Graneli.
Marine Ecology Progress Series MESEDT, Vol. 61, No. 3, p 215-231, 1990. 9 fig, 8 tab, 65 ref.

Descriptors: *Cycling nutrients, *Diurnal variation, *North Sea, *Plankton, Abundance, Bacteria, Chlorophyll a, Flagellates, Growth, Nitrogen, Phosphorus, Primary production, Salinity, Sedimentation, Skagerrak, Stratification.

In May 1987, multidisciplinary investigations focusing on diel variations were performed at 4 horizontally stratified (pycnocline at 5 to 12 m) stations in the open Skagerrak (North Sea). Nutrients were lower above the pycnocline than below. Phytoplankton was numerically dominated by flagellates and monads indicating a regenerating plankton community, which was confirmed by the finding that about 80% of the nitrogen uptake in surface waters was as NH4(+) and urea, and about 20% was NO3(-). Percentage of 'new' primary production (based on NO3(-) uptake) was similar to the percentage sedimentation rate (in C) of primary production (20%). Growth of bacteria and grazing on bacteria were systematically dependent on time of day above, in and below the pycnocline. Abundance of bacteria and nanoflagellates was not regularly dependent on time of day, but systematically elevated in the pycnocline, as was chlorophyll a. Zooplankton grazing in the surface water was highest at night and early morning. Benthic investigations indicated heterogeneity in the area. For comparison, samples of hydrography, nutrients, phytoplankton abundance and growth, and sedimentation were investigated at the same time at a coastal station with horizontal stratification and slightly lower salinity. Here 'new' primary production was estimated to be about 50% of total production, based on percentage sedimentation. Nitrogen seemed to be in deficit for primary production relative to phosphorus in surface waters both in the open and coastal Skagerrak, but exceptions could occur. That nutrients were in surplus just below the shallow pycnocline shows, that those primary producers and bacteria which could utilize this reservoir had access to unlimited nutrient resources at that time. It was estimated that bacteria and flagellates made up >50% of total pelagic

respiration and consumed slightly more than the net primary production. (Author's abstract)
W90-08716

QUANTITATIVE EXAMINATION OF MACRO-BENTHIC COMMUNITY CHANGES ALONG AN ORGANIC ENRICHMENT GRADIENT.
Washington Univ., Seattle. School of Oceanography.
D. P. Weston.
Marine Ecology Progress Series MESEDT, Vol. 61, No. 3, p 233-244, 1990. 9 fig, 2 tab, 40 ref. EPA Cooperative Agreement CX-813705-01.

Descriptors: *Aquaculture, *Benthic fauna, *Organic pollutants, *Puget Sound, *Trophic level, *Water pollution effects, Benthos, Community structure, Macroinvertebrates, Population dynamics, Size, Water pollution sources.

Organic enrichment, both natural and anthropogenic, is one of the most common forms of disturbance in the benthos. The effects of organic enrichment on the benthos in the vicinity of a large mariculture facility located in Puget Sound, WA were examined as a general model for enrichment, without the confounding effects of toxicants often associated with anthropogenic inputs. Stations nearest the facility were subject to continuous input of fish feed and fecal matter, and gross structural changes in the macrofaunal community (e.g. reduced species richness, dominance of opportunistic species) were similar to those commonly reported for other enriched sites. More complex community and population responses were indicated by changes in body size, vertical distribution of infauna and patterns of trophic dominance. Enriched areas are generally assumed to be characterized by macrofauna with small body size, and mean individual size did, in fact, decrease with proximity to the farm. At stations farthest from the farm, however, size distributions were skewed by a few large individuals, indicating that trends in mean individual size are susceptible to the methodological limitations inherent in adequately sampling rare individuals. While interspecific measures of animal size decreased with increasing enrichment, intraspecific measures indicated a tendency for larger individuals to occur at the most enriched sites. Enriched areas may represent increased food resources, and thus increased potential for growth and attainment of larger body sizes in those species capable of exploiting such habitats. Increasing organic enrichments resulted in the loss of large, deep-dwelling species and dramatically altered the vertical biomass profiles, but because these individuals were numerically few, had little effect on the vertical abundance profiles. Changes in trophic dominance did occur along the enrichment gradient, but the general lack of autecological information limits current efforts to define trophic groups and assign species to them. The utility of trophic grouping approaches in identification of enrichment-induced disturbances is thus limited. (Author's abstract)
W90-08717

PHYSICAL CHARACTERISTICS OF SALT MARSH SEDIMENTS: ECOLOGICAL IMPLICATIONS.
South Carolina Univ., Columbia. Dept. of Marine Science.
For primary bibliographic entry see Field 2J.
W90-08718

POLYCHAETE POPULATION DYNAMICS AND PRODUCTION IN THE NEW YORK BIGHT ASSOCIATED WITH VARIABLE LEVELS OF SEDIMENT CONTAMINATION.
National Marine Fisheries Service, Highlands, NJ. Sandy Hook Lab.
For primary bibliographic entry see Field 5C.
W90-08720

MERCURY CONTENT OF COPEPODS (CRUSTACEA) COLLECTED FROM THE ANTARCTIC SEA.
Kumamoto Univ. (Japan). Aitsu Marine Biological Station.

For primary bibliographic entry see Field 5B.
W90-08721

PHYSICAL BEHAVIOUR OF A LARGE, NEGATIVE OR INVERSE ESTUARY.
University Coll., Campbell (Australia). Dept. of Geography and Oceanography.
R. A. Nunes Vaz, G. F. Lennon, and D. G. Bowers.
Continental Shelf Research CSHRDZ, Vol. 10, No. 3, p 277-304, March 1990. 19 fig, 38 ref.

Descriptors: *Estuaries, *Negative estuaries, *Saline-freshwater interfaces, *Water circulation, Australia, Salinity, Seasonal variation, Spencer Gulf, Turbulence, Water temperature.

The observational behavior of a large, negative or inverse estuary is explained by theoretical, and laboratory models of gravitationally driven circulation. The characteristics of Spencer Gulf, South Australia, in which evaporation exceed precipitation all year round, and the spring-neap tidal cycle is greatly exaggerated, make it particularly instructive with regard to the role of turbulence in controlling the strength of baroclinic circulation, and hence the exchange between Gulf and shelf waters. Seasonal influences, involving the reversal of the temperature gradient across the mouth, are shown to have a profound impact on this Gulf-shelf exchange. The development of strong temperature and salinity fronts which are compensatory with respect to density, removes almost all baroclinic forcing in the region and effectively blocks communication across the Gulf entrance during summer. It is apparent that the equilibrium of such systems relies on the sensitive interplay of influences primarily related to the nature of the change from estuary to shelf regime across the entrance, and the variability of turbulence in the region. (Author's abstract)
W90-08728

TRANSLOCATION OF AN ESTUARINE WHELK AND ITS TREMATODE PARASITES IN AUSTRALIA.
Scripps Institution of Oceanography, La Jolla, CA.
For primary bibliographic entry see Field 4C.
W90-08729

THERMALLY DRIVEN CIRCULATION WITHIN AN EXPERIMENTAL ENCLOSURE.
Sveriges Meteorologiska och Hydrologiska Inst., Goeteborg. Oceanografiska Lab.
For primary bibliographic entry see Field 7B.
W90-08734

INTERPOPULATIONAL DIFFERENCES IN SALT TOLERANCES OF TWO CLADOPHORA SPECIES.
Liverpool Univ. (England). Dept. of Environmental and Evolutionary Biology.
D. N. Thomas, J. C. Collins, and G. Russell.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 2, p 201-206, February 1990. 1 fig, 2 tab, 20 ref.

Descriptors: *Chlorophyta, *Cladophora, *Salt tolerance, Photosynthesis, Potassium, Salinity, Sodium.

The effects of changes in external salinity upon Baltic and U.K. populations of Cladophora rupestris (L.) Kutz and C. glomerata (L.) Kutz have been studied. Rates of net photosynthesis after salinity treatment (0-102 ppt) were used as a measure of salinity tolerance. There were very pronounced differences in the salt tolerance of the two C. glomerata populations, whereas Baltic and U.K. C. rupestris differed significantly only in responses to extreme hyposaline treatment. The effect of salinity on the thallus content of potassium ions and sodium ions was measured. There were significant differences in the ratios of these ions in populations both species. The populations also differed significantly in the dimensions of their cells and cellular volume. (Author's abstract)
W90-08737

DETERMINATION OF PALLADIUM AND PLATINUM IN SEAWEED.
Korea Ocean Research and Development Inst., Seoul (Republic of Korea). Polar Research Div.
For primary bibliographic entry see Field 5A.
W90-08738

PLANKTON COMMUNITY RESPIRATION ALONG A NUTRIENT GRADIENT IN A SHALLOW DANISH ESTUARY.
Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab.
L. M. Jensen, K. Sand-Jensen, S. Marcher, and M. Hansen.
Marine Ecology Progress Series MESEDT, Vol. 61, No. 1/2, p 75-85, March 1990. 5 fig, 7 tab, 41 ref.

Descriptors: *Bacterial physiology, *Bacterioplankton, *Biomass, *Estuarine environment, *Phytoplankton, *Plankton, *Respiration, Denmark, Eutrophication, Oxygen, Population dynamics, Regression analysis.

Plankton community respiration was examined in a shallow, very eutrophic Danish estuary during April to September. Maximum rates (3.98 g oxygen/ cu m/day) were measured during the phytoplankton spring bloom in the most eutrophicated inner parts. Community respiration was significantly related to biomass and gross productivity of phytoplankton and net production of bacterioplankton. The relationship was weak to temperature and bacterial biomass. Regression analysis suggested that phytoplankton and bacteria, on average, accounted for 64 to 83% of the community respiration at the 2 most eutrophic localities. The regressions also provided estimates of the mean phytoplankton respiration (0.76 mg oxygen/mg chlorophyll a/hour, 6.0% of gross productivity), mean bacterial respiration (1.4 times net production) and mean bacterial growth yield (42%). Pelagic respiration exceeded benthic respiration and became proportionally larger with increasing eutrophication and phytoplankton productivity in the inner parts of the estuary. These results stress the importance of phytoplankton blooms for pelagic respiration, overall oxygen balance and oxygen depletion phenomena. (Author's abstract)
W90-08740

BENTHIC NH4(+) AND NO3(-) FLUX FOLLOWING SEDIMENTATION OF A SPRING PHYTOPLANKTON BLOOM IN AARHUS BIGHT, DENMARK.
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.
M. H. Jensen, E. Lomstein, and J. Sorenson.
Marine Ecology Progress Series MESEDT, Vol. 61, No. 1/2, p 87-96, March 1990. 3 fig, 1 tab, 47 ref.

Descriptors: *Algal growth, *Ammonium, *Estuarine environment, *Nitrates, *Nitrification, *Phytoplankton, *Sedimentation, Aarhus Bight, Denmark, Oxygen penetration depth, Seasonal variation, Sediment-water interfaces.

A seasonal study of ammonium ion and nitrate ion fluxes and concentrations at the sediment-water interface was carried out at a 15 m deep station in Aarhus Bight, Denmark. In winter, ammonium and nitrate ions were released from the sediment at comparable rates (0.20 to 0.40 mmol N/sq m/d). A phytoplankton bloom developed rapidly in early spring. Immediately after mass sedimentation of diatoms, the sediment transiently released ammonium ions at a high rate (up to 1.5 mmol N/sq m/d) and a dramatic change to a nitrate uptake was observed (flux circa -0.80 mmol N/sq m/d). Subsequently both the ammonium ion release and the nitrate ion uptake decreased (summer fluxes of approximately 0.35 and -0.15 mmol N/sq m/d, respectively). From late summer, nitrate was again released from the sediment (about 0.30 mmol N/sq m/d) and a second, weaker maximum of ammonium ion release (about 0.70 mmol N/sq m/d) was observed in the fall. Seasonal variation of ammonium and nitrate ion concentration at the sediment surface (upper 2 mm) and in the bottom water

agreed well with observed flux patterns. The high ammonium ion release and nitrate ion uptake immediately after spring bloom sedimentation indicated rapid increases of mineralization and denitrification. Sediment nitrification seemed to be inhibited, however, probably because the oxygen penetration depth was reduced after sedimentation. Uptake of bottom water nitrate ions rather than nitrification therefore seemed to support the denitrification maximum. Even when calculated for a whole year, about 50% of the nitrate ions consumed during denitrification was supplied from the bottom water. Annual nitrogen budgets also indicated that denitrification accounted for 25% of the total inorganic nitrogen release from the sediment. (See also W90-08742) (Author's abstract)
W90-08741

INTRACELLULAR NH4(+) AND NO3(-) ION POOLS ASSOCIATED WITH DEPOSITED PHYTOPLANKTON IN A MARINE SEDIMENT (AARHUS BIGHT, DENMARK).
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.
E. Lomstein, M. H. Jensen, and J. Sorenson.
Marine Ecology Progress Series MESEDT, Vol. 61, No. 1/2, p 97-105, March 1990. 6 fig, 39 ref.

Descriptors: *Algal physiology, *Ammonium, *Estuarine environment, *Interstitial water, *Nitrates, *Nitrogen cycle, *Sediment chemistry, Aarhus Bight, Denmark, Freezing, Seasonal variation.

Concentration profiles of ammonium and nitrate ions in pore water and particulate matter were determined at high spatial resolution (mm scale) in surface sediment from a coastal bay area (Aarhus Bight, Denmark) at 15 m depth during an annual cycle. Pore water pools of ammonium and nitrate ions were always considerably lower than particulate pools in the surface sediment. Particulate ammonium and nitrate ions were apparently intracellular pools in deposited microalgae and were extracted after freezing sediment samples in liquid nitrogen (-196 C). Pore water ammonium ions and most of the adsorbed (potassium chloride extractable) ammonium ions were also extracted by the freezing technique, and an estimate of the intracellular ammonium and nitrate ions were always observed in the upper 2 mm of sediment, declining sharply with depth. A distinct seasonal maximum for both pools, approximately 200 nmol/cu cm at 0-2 mm depth, appeared after sedimentation of a phytoplankton bloom in early spring, and should be compared to a minimum of only 25 nmol/cu cm or less in fall and winter. The freeze-extraction technique is proposed for a reliable estimate of intracellular ammonium and nitrate ion pools in surface sediments rich in microalgae, and may thus be used as an indicator of sedimentation of phytoplankton blooms. The significance of intracellular pools for sediment nitrogen cycling is not well understood. (See also W90-08741) (Author's abstract)
W90-08742

SMALL-SCALE ORGANISM DISTRIBUTIONS AND PATTERNS OF SPECIES DIVERSITY: EVIDENCE FOR POSITIVE INTERACTIONS IN AN ESTUARINE BENTHIC COMMUNITY.
Virginia Inst. of Marine Science, Gloucester Point.
L. C. Schaffner.
Marine Ecology Progress Series MESEDT, Vol. 61, No. 1/2, p 107-117, March 1990. 3 fig, 5 tab, 41 ref.

Descriptors: *Benthic environment, *Benthic fauna, *Ecosystems, *Estuarine environment, *Species diversity, Abundance, Box cores, Correlation analysis.

Previously, roles of physical factors and negative interactions in estuarine community organization have been emphasized. Recent studies suggest, however, that promotive processes can be important in structuring some soft-substrate communities. For this study, patterns of faunal abundance, small-scale (centimeters to decimeters) distribution, and species association, are evaluated to assess the relative importance of positive species interactions or promotive processes in the regulation of an estuarine macrobenthic community. Based on living positions and habits, the dominant fauna collected in 70 box cores (0.06 sq m) during a 13 month period was classified into five major functional groups: (1) large tube and burrow builders, (2) small tube builders, (3) shallow burrowers, (4) deep burrowers, (5) epifaunal and tube or burrow coinhabitants. Positive correlations were more common (up to 52% of pairwise comparisons of abundance among groups of species) than negative correlations (up to 6%). Highest percentages of positive correlations were observed among Group 4 species (53%) and between Groups 1 and 4 (38%). Highest percentages of negative correlations occurred between Groups 2 and 1 (6%). The large tube-building polychaete Chaetopterus variopedatus directly influenced organism abundance and species composition of near-surface fauna (less than or equal to 5 cm). Number of species, diversity and faunal abundance were greater in samples that contained C. variopedatus than in samples that did not; most organisms exhibiting enhanced abundance were living on the tube above the sediment-water interface. The head-down feeding polychaete Macroclymene zonalis had no significant effect on species diversity or organism abundance in near-surface sediments. These patterns of species abundance and association suggest that biogenic alteration of the sedimentary environment, especially through sediment amelioration and the provision of substrate, modifies habitat availability and thereby provides a positive mechanism by which organism abundance and community structure are influenced. (Author's abstract)
W90-08743

PRIMARY AND BACTERIAL PRODUCTIVITY OF TROPICAL SEAGRASS COMMUNITIES IN THE GULF OF CARPENTARIA, AUSTRALIA.
Commonwealth Scientific and Industrial Research Organization, Cleveland (Australia). Marine Labs.
D. J. W. Moriarty, D. J. Roberts, and P. C. Pollard.
Marine Ecology Progress Series MESEDT, Vol. 61, No. 1/2, p 145-157, March 1990. 7 fig, 9 tab, 38 ref.

Descriptors: *Bacterial physiology, *Biomass, *Dissolved oxygen, *Ecosystems, *Estuarine environment, *Plant growth, *Plant physiology, *Primary productivity, *Sea grasses, *Seasonal variation, Australia, Carbon cycle, DNA, Gas production, Gulf of Carpentaria.

Plant and bacterial productivities were compared at different seasons in three communities of seagrass in the Gulf of Carpentaria, Australia, in 1985. Seagrass biomass and shoot density were very variable, with no seasonal trend. The gross primary productivity of the seagrasses in each of the communities (Syringodium isoetifolium with Cymodocea serrulata in a bay, Halodule uninervis at a river mouth, and Thalassia hemprichii with Cymodocea rotundata on a reef flat) were determined seasonally from rates of lacunal gas production. Productivity varied seasonally, being lowest in winter (July). Values ranged from 0.6 to 1.0 g carbon/square meter/day for C. serrulata, 0.3 to 8.1 for S. isoetifolium, 0.9 to 3.5 for H. uninervis, 0.2 to 0.4 for T. hemprichii and 0.1 to 1.0 for C. rotundata. Gross community primary productivity, measured from diurnal changes in oxygen concentration in the water column, ranged from 3.3 in winter to 9.3 g carbon/square meter/day in summer at the bay site, 2.7 to 4 at the river mouth and 3.3 to 8.4 on the reef flat. Bacterial productivity was determined using the rate of tritiated thymidine incorporation into DNA. Most (90 to 95%) bacterial biomass was produced in the sediment. Between winter and summer, total bacterial productivity (including water column) ranged from 1.0 to 4.8 g carbon/square meter/day in the bay, 0.6 to 2.5 at the river mouth and 0.6 to 3.7 on the reef flat. Bacterial productivity averaged 43% (range 10 to 90%) of gross primary productivity, and thus would account for about half of the primary production if their growth efficiency were 50%. Animals appeared to have an impact on bacteria at the sediment surface in summer, when specific growth rates and productivity were high, but numbers were low. (Author's abstract)

W90-08744

INTERACTION BETWEEN AMMONIUM AND NITRATE UPTAKE IN PHYTOPLANKTON.
Louisiana Universities Marine Consortium, Chauvin.
Q. Dortch.
Marine Ecology Progress Series MESEDT, Vol. 61, No. 1/2, p 183-201, March 1990. 5 tab, 134 ref.

Descriptors: *Limnology, *Estuarine environment, *Ammonium, *Nitrates, *Phytoplankton, *Nitrogen cycling, *Nutrient utilization, Limiting nutrients.

A basic tenet of nitrogen utilization in phytoplankton is that ammonium inhibits nitrate uptake. Consequently, it is generally believed that little or no nitrate uptake occurs at ammonium concentrations above approximately 1 micromole. A thorough review of field studies shows the reduction of nitrate uptake rate in the presence of ammonium is rarely so severe, and that it is a highly variable phenomenon. To simplify quantification of the interaction between nitrate and ammonium uptake, it is proposed that it be divided into an indirect interaction, preference, and a direct effect, inhibition. In order to determine preference and inhibition it is necessary to measure uptake of each inorganic nitrogen source alone and in the presence of increasing concentrations of the other nitrogen source. Preference for ammonium uptake is manifested primarily in a higher V(max) and K(s) for ammonium uptake than for nitrate uptake and is accentuated by low light and low nitrogen availability. However, although ammonium is the preferred nitrogen source for uptake by ammonium is much more variable, but when separated from preference is less extreme. It is also enhanced by low light, but unlike preference, it is greater when phytoplankton are nitrogen sufficient. Species differences are apparent for both preference and inhibition, but there are only enough data for preference to determine how it varies among algal groups. Finally, there are reports of low concentrations of ammonium stimulating nitrate uptake and of nitrate inhibiting ammonium uptake. Such unexpected interactions along with variations in preference and inhibition with species composition and environmental conditions may account for variability observed in field studies and will not be explained or predictable until more is known about is known about the underlying biochemical mechanisms. Even though it is not possible at present to model nitrate uptake accurately because of uncertainty about the interaction between ammonium and nitrate uptake, it is quite evident that the simplistic view that nitrate uptake is reduced to zero if ammonium exceeds 1 micromole would often result in large underestimates of nitrate uptake and new production. (Author's abstract)
W90-08745

MODELING IN SITU PHYTOPLANKTON ABSORPTION FROM TOTAL ABSORPTION SPECTRA IN PRODUCTIVE INLAND MARINE WATERS.
Washington Univ., Seattle. School of Oceanography.
C. S. Roesler, M. J. Perry, and K. L. Carder.
Limnology and Oceanography LIOCAH, Vol. 34, No. 8, p 1510-1523, December 1989. 13 fig, 2 tab, 46 ref. NASA Grants NAGW-465, NAGW-485, and NAGW-889 and ONR Grants N00014-88-J-1017 and N00014-87-K-0160.

Descriptors: *Light penetration, *Marine environment, *Optical properties, *Phytoplankton, Organic compounds, Primary productivity, San Juan Islands, Spectrometry, Washington.

Dissolved and suspended materials in the ocean modify the in-water light field by absorbing and scattering photons. Direct measurement of inherent optical properties of individual optical constituents is difficult because the constituents themselves cannot all be separated. A model was developed to resolve in situ phytoplankton absorption from a measured in situ total absorption spectrum that includes water, dissolved organics, particulate de-

tritus, and phytoplankton. The model was tested on a set of absorption spectra obtained from the productive waters around the San Juan Islands, Washington. Results indicate that the model can predict the spectral shape of phytoplankton absorption (r squared = 0.9) and total photon absorption by phytoplankton with <27% error. Total photon absorption can be used to estimate phytoplankton absorption of light energy for improved predictions of primary production, given submarine light field measurements or model calculations. Although developed for high-chlorophyll waters, the model parameters are modified easily for various optical domains. (Author's abstract)
W90-08967

SURFACE WATER-QUALITY STUDIES IN THE INTERIOR MARINE ENVIRONMENT OF DENMARK.
Copenhagen Univ. (Denmark). Geophysical Inst.
N. K. Hojerslev.
Limnology and Oceanography LIOCAH, Vol. 34, No. 8, p 1630-1639, December 1989. 14 fig, 20 ref.

Descriptors: *Denmark, *Light penetration, *Marine environment, *Suspended solids, Baltic Sea, Degradation, Fluorescence, Gelbstoff, Kattegat, Oresund, Primary productivity, Salinity, Seasonal distribution, Store Baelt, Temperature.

Suspended matter in terms of light scattering and gelbstoff in terms of fluorescence, temperature, and salinity were measured on surface samples taken from Ore Sund, the Kattegat, the Store Baelt, and the Baltic in January and August 1975 during the Danish Belt Project. For the area investigated, the average surface concentration of suspended matter attained its maximum in January 1975, being of the order of 10 times. For August 1975, this variation dropped appreciably, to the order of two times. The overall horizontal variation of surface gelbstoff concentration was about the same for January and August 1975, being of the order of two times. This suggests that biological activities such as primary production and organic decay are unrelated to the formation of gelbstoff in the sea. Two older surface maps based on light scattering measurements from the Ore Sund in April 1957 and November 1953 suggest that the surface concentration of suspended matter has more than tripled during the period 1953-1975. (Author's abstract)
W90-08968

PRELIMINARY STUDY ON THE ECOLOGY OF THE BENTHIC MEIOFAUNA IN THE HUANGHE RIVER ESTUARY AND ITS ADJACENT WATERS (IN CHINESE).
Academia Sinica, Qingdao (China). Inst. of Oceanology.
Z. Zhang, Y. Li, L. Tu, and Z. Yu.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 20, No. 3, p 197-208, 1989. 5 fig, 3 tab, 23 ref. English summary.

Descriptors: *Benthic fauna, *Benthos, *China, *Estuaries, *Estuarine environment, Biomass, Bohai Bay, Copepods, Huang He River, Invertebrates, Laizhou Bay, Nematodes, Ostracods, Sediments, Spatial distribution.

The benthic meiofauna (metazoa <0.5 mm) was investigated quantitatively in the Huanghe River estuary and its adjacent waters at 20 stations during the summer of 1986. Mean meiofaunal abundance amounted to 789 +/-293 individuals per 10 sq cm. Free-living marine nematodes constituted 66.5% of the total, with the mean density of 527 +/-262 individuals per sq cm, and were the most abundant organisms at all stations. Harpacticoid copepods were second in overall abundance, constituting 16.7% of the total with the mean density of 131 +/-73 individuals per 10 sq cm. Ostracoda constituted the lowest percentage (4.7%), with 20 +/-28 individuals per 10 sq cm. The percentage of nematodes decreased with depth and distance from the river mouth, whereas the percentage of Copepoda increased. The change of the percentage of nematodes and copepods well reflected the change of sedimentary composition. Based on the results obtained, together with the data of the abundance, biomass and numbers of

macrofauna species, the investigation area may be divided into subaquatic delta, the Laizhou Bay, the central part of Bohai, and the southeast part of Bohai Bay. These areas coincide well with natural zones. The subdivision of meiofauna can be related to the depth and sedimentary environment (sedimentation rate and composition of sediment). (Author's abstract)
W90-09024

ANALYSES OF STABILITY OF THE BAR CHANNEL OF FANGCHENG HARBOR (IN CHINESE).
Academia Sinica, Qingdao (China). Inst. of Oceanology.
Z. Yang, G. Lin, L. Wu, M. Jiang, and H. Yue.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 20, No. 3, p 244-251, 1989. 5 fig, 8 ref. English summary.

Descriptors: *Channel flow, *Channel stability, *China, *Fangcheng Bay, *Sandbars, *Sediment transport, *Sedimentation, Bars, Harbors, Tidal currents, Tides, Waves.

The water depth of bar channel at the mouth of Fangcheng Bay formerly was 2m, but now it is -7.5 m as the result of dredging. The annual accumulation of sediment is about tens of thousands of cubic m. Deposition occurs during the summer and erosion during the winter; the southern part is the deposition area, whereas the north is the erosion area. A typhoon had little effect in terms of channel blockage and the stability of the bar channel is good. The interaction among sediments, waves, and tidal currents were analyzed based on many years of data. The sediments are not abundant. The wave height is no more than 0.8 m and the frequency is low (p = 17.71%). The angle between the channel and main wave direction is small, so the alongshore drift is weak and topographic change of the bar is small. The tidal influx is great in Fangcheng Bay. The flood (ebb) tide current velocity increases (decreases) along the bar channel, the velocity of ebb tidal current is higher than that of flood tidal current. The asymmetry of tidal current is the main factor contributing to stability of the bar channel in Fangcheng harbor. (Author's abstract)
W90-09025

GEOCHEMISTRY OF FE, MN, CA, MG IN SEDIMENTS AND INTERSTITIAL WATER OF THE FERROMANGANESE NODULE ENRICHMENT AREA FROM NORTH PACIFIC (IN CHINESE).
National Bureau of Oceanography, Hangzhou (China). Second Inst. of Oceanography.
For primary bibliographic entry see Field 2J.
W90-09026

SEAWATER INTRUSION INTO ESTUARIES AND AQUIFERS.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
M. G. Khublaryan, and A. P. Frolov.
Publications of the Water and Environment Research Institute PWEIET, No. 3, p 40-47, 1989. 4 fig, 6 ref.

Descriptors: *Coastal aquifers, *Estuaries, *Hydrologic models, *Model studies, *Saline water intrusion, Confined aquifers, Convection, Groundwater flow, Mathematical models, Saline-freshwater interfaces, Solute transport.

Study of sea-water intrusion into estuaries, river mouths, and aquifers recently has become an urgent problem due to the high rate of withdrawal of fresh water from rivers and aquifers in coastal areas. Mathematical models were formulated and some approximate analytical solutions are presented here for problems of saline-water intrusion into estuaries and freshwater aquifers. Unsteady one-dimensional models of convective salt transfer in an estuary with a variable cross-section and steady circulating flows in a two-dimensional, vertically slightly stratified river mouth are examined. The problem of defining the interface between fresh and saline waters in a confined aquifer also is

considered both for movement of two immiscible liquids and miscible liquids (salt convective diffusion). The models described may be used for estimating water quality variations in estuaries, river mouths, and coastal freshwater aquifers. (Author's abstract)
W90-09031

SEDIMENTATION DYNAMICS IN THE SANTA MONICA-SAN PEDRO BASIN OFF LOS ANGELES: RADIOCHEMICAL, SEDIMENT TRAP AND TRANSMISSOMETER STUDIES.
Oregon State Univ., Corvallis. Coll. of Oceanography.
For primary bibliographic entry see Field 2J.
W90-09035

EBB-TIDAL FRONTS IN CHARLESTON HARBOR, SOUTH CAROLINA: PHYSICAL AND BIOLOGICAL CHARACTERISTICS.
Charleston Coll., SC. Grice Marine Biological Lab.
J. Pinckney, and P. Dustan.
Estuaries ESTUDO, Vol. 13, No. 1, p 1-7, March 1990. 7 fig, 2 tab, 20 ref.

Descriptors: *Estuaries, *Estuarine environment, *Saline-freshwater interfaces, *South Carolina, *Tidal currents, *Tidal effects, *Tidal hydraulics, Charleston Harbor, Density currents, Phytoplankton, Salinity, Turbidity currents, Zooplankton.

Surface accumulations of foam and flotsam as well as sharp salinity, density, and turbidity gradients, and regions of acoustic scatter were characteristic of ebb-tidal fronts in Charleston Harbor, South Carolina. Surface convergence velocities at these fronts averaged 0.06 m/sec into the front at an angle of 30 to 60 degrees with respect to the frontal axis, indicating along-front transport during the ebb. These fronts are tidally-induced, forming on the late flood and ebb along the interfaces of water masses. Horizontal and vertical measurements of density revealed that the upper harbor fronts form along the margin of a freshwater lens produced by riverine input. The hypothesis that these frontal zones have higher densities of phytoplankton and zooplankton than adjacent water masses was tested using chlorophyll a measurements and net collections. The fronts did not demonstrate any significant accumulations of phytoplankton or zooplankton during the ebb tide. The results of this study suggest that the physical characteristics of ebb-tidal estuarine fronts in Charleston Harbor are periodic in nature and may indirectly affect plankton transport in this coastal plain estuary. (Author's abstract)
W90-09037

BEHAVIOR OF TRACE METALS IN THE GEUM ESTUARY, KOREA.
Skidaway Inst. of Oceanography, Savannah, GA.
J. T. Byrd, K. W. Lee, D. S. Lee, R. G. Smith, and H. L. Windom.
Estuaries ESTUDO, Vol. 13, No. 1, p 8-13, March 1990. 8 fig, 26 ref. NSF Grants OCE-8600287 and INT-8600288.

Descriptors: *Dissolved oxygen, *Estuaries, *Geochemistry, *Hydrogen ion concentration, *Korea, *Salinity, *Trace metals, Cadmium, Cobalt, Estuarine sediments, Iron, Manganese, Nickel, Zinc.

The estuarine behavior of trace metals differs in different estuaries, and these differences should be reconciled with regard to the chemistry, hydrography, and physical characteristics of each estuary. The distributions of trace metals in the Geum Estuary of western Korea were studied with regard to changes in other estuarine chemical parameters. The Geum estuary is an example of a macrotidal temperate estuary which drains a predominantly granitic terrane. Dissolved oxygen, pH, and alkalinity increased with increasing salinity. Dissolved aluminum concentrations increased at low salinities and were perhaps influenced by the solubility of particulate aluminosilicate phases. Iron, manganese, cobalt, and zinc are removed

from solution in the low salinity end of the estuary. Cobalt and nickel have mid-estuary concentration maxima that may be due to an anthropogenic source. Cadmium, copper. lead, and zinc concentrations also increased in the estuary, possibly as the result of remobilization in the sediments. Cadmium increases are also linked to remineralization from tidal flat sediments in the outer estuary. The source of an increase in dissolved lead at low salinity is unclear, but may be due to release from particles. (Author's abstract)
W90-09038

STABLE ISOTOPES AND CELLULASE ACTIVITY AS EVIDENCE FOR DETRITUS AS A FOOD SOURCE FOR JUVENILE GULF MENHADEN.
Massachusetts Univ., Amherst. Dept. of Forestry and Wildlife Management.
L. A. Deegan, B. J. Peterson, and R. Portier.
Estuaries ESTUDO, Vol. 13, No. 1, p 14-19, March 1990. 1 fig, 3 tab, 23 ref. NSF Grant DEB 81-04701.

Descriptors: *Estuarine fisheries, *Fish diets, *Fish food, *Menhaden, *Spartina, Atlantic Ocean, Cellulose, Gulf of Mexico, Phytoplankton, Stable isotopes, Zooplankton.

Menhaden are one of the most abundant components of fish communities in Gulf and Atlantic estuaries. Juvenile menhaden have been reported to have zooplankton, phytoplankton, and Spartina-derived detritus in their gut. The abundance of detritus in the estuarine areas which the Gulf menhaden use as a nursery ground, and the consistent reports of detritus in Gulf menhaden gut contents, suggest they are using Spartina detritus as a food source, although there has been disagreement on this point. Stable carbon isotope analysis of food pathways in a Georgia estuary indicated Atlantic menhaden depend only on phytoplankton-derived carbon; however, using stable isotopes of a single element is not definitive. For this study, larvae, juvenile, subadult, and adult menhaden were collected, placed on ice in the field, and analyzed for cellulase activity within 36 hours. The ratios of heavy to light stable isotopes were determined in muscle tissue for delta S34, delta C13, and delta N15. A multiple isotope approach provides significantly more power to resolve food sources than a single isotope, because the combination of two or three isotopes may describe a unique region of isotope values for each organic matter source. Almost all of the cellulase-active colonies were identified as Pichia spartinea, one of the dominant yeasts in the microflora of the Louisiana marshlands and strongly associated with Spartina detritus. The stable isotope evidence is consistent with the use of Spartina detritus as a food source. As Spartina detritus is a low quality food, it is possible that the role of the detritus in the diet of menhaden may be as a caloric supplement to increase the efficiency of digesting other richer food types, such as zooplankton. (Tappert-PTT)
W90-09039

USE OF DETRITAL FOODS AND ASSIMILATION OF NITROGEN BY COASTAL DETRITIVORES.
Hampshire Coll., Amherst, MA.
C. D'Avanzo, and I. Valiela.
Estuaries ESTUDO, Vol. 13, No. 1, p 20-24, March 1990. 2 fig, 1 tab, 24 ref. NSF Grant OCE-8315917.

Descriptors: *Fish diets, *Fish food, *Killifish, *Nitrogen cycle, *Salt marshes, *Spartina, Isotope studies, Massachusetts.

Two killifish common in east coast U.S.A. salt marshes, Cyprinodon variegatus Lacepede and Fundulus heteroclitus Walbaum, differ in their ability to assimilate nitrogen from and grow on detritus. C. variegatus grew on a diet of detritus of Spartina alterniflora Loisel, while F. heteroclitus did not. In addition, when the fish were fed N15-labeled S. alterniflora detritus, N15:N14 ratios in C. variegatus were higher than were ratios in F. heteroclitus. Therefore, even though both species ingest large amounts of detritus, C. variegatus

makes more effective use of this portion of its diet. These dietary differences are corroborated by anatomical differences that suggest that C. variegatus should make better use of detrital or plant tissues than F. heteroclitus. In the label experiment, the degree of label in both fish was directly proportional to the degree of label in the food treatments. In previously published experiments designed to compare plant substrate with attached microbes as nitrogen sources for detritivores, the percent N15 incorporated by a polychaete was also directly proportional to the percent N15 in the detrital food. Therefore, it is difficult to distinguish between plant substrate and microbes as nitrogen sources for this detritivore. (Author's abstract)
W90-09040

RESTORATION OF AN IMPOUNDED SALT MARSH IN NEW ENGLAND.
Connecticut Coll., New London. Dept. of Botany.
T. L. Sinicrope, P. G. Hine, R. S. Warren, and W. A. Niering.
Estuaries ESTUDO, Vol. 13, No. 1, p 25-30, March 1990. 4 fig, 9 ref.

Descriptors: *Marsh management, *Marsh plants, *Phragmites, *Salt marshes, *Spartina, *Tidal marshes, *Wetland restoration, *Wetlands, Cattails, Connecticut.

The restoration of a 20 ha tidal marsh, impounded for 32 years, in Stonington, Connecticut, was studied to document vegetation changes 10 years after the reintroduction of tidal flushing. These data were then compared to a 1976 survey of the same marsh when it was in its freshest state and dominated by Typha augustifolia. Currently, T. augustifolia remains vigorous only along the upland borders and in the upper reaches of the valley marsh. Live coverage of T. augustifolia has declined from 74% to 16% and surviving stands are mostly stunted and depauperate. Other brackish species have also been adversely affected, except for Phragmites australis which has increased. In contrast, the salt species Spartina alterniflora has dramatically expanded, from <1% to 45% cover over the last decade. Locally, high marsh species have also become established, covering another 20% of the marsh. After a decade of restoration, the Typha monoculture which developed following impoundment has been largely eliminated. (Author's abstract)
W90-09041

VARIATIONS IN THE ONSET OF BOTTOM-WATER INTRUSIONS OVER THE ENTRANCE SILL OF A FJORD.
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
G. A. Cannon, J. R. Holbrook, and D. J. Pashinski.
Estuaries ESTUDO, Vol. 13, No. 1, p 31-42, March 1990. 8 fig, 2 tab, 22 ref.

Descriptors: *Fjords, *Ocean circulation, *Puget Sound, *Saline water intrusion, *Salinity currents, Estuaries, Water circulation.

Puget Sound is fjord-like estuary and bottom-water intrusions are major circulation features which play a dominant role in the replacement of water below sill depth. New observations on the inside and outside of the entrance sill show that, while intrusions occur during neap tides as previously thought, the onset of the intrusions is a result of fluctuations in the horizontal density gradient caused by salinity variations across the sill. Salinity changes outside the sill in the Strait of Juan de Fuca estuary appear to be the result of storms on the Pacific coast causing reversals of surface flow and variations in deep flow more than 135 km from the coast. Previous observations have shown deep salinity variations midway along the Strait, but these are the first to show this effect can penetrate the full length of the Strait causing near-bottom salinity variations of sufficient magnitude to influence flow into Puget Sound. This influence probably occurs from the onset of storms in autumn through subsidence in spring, although occasional large storms occur in summer. Although Puget Sound is more characteristic of a fjord, the simple

model calculations here suggest similar processes may occur in lower-layer flow at the mouth of coastal plain estuaries. (Author's abstract)
W90-09042

DISTRIBUTION AND ABUNDANCE OF ICHTHYOPLANKTON IN THE MANICOUAGAN ESTUARY, A TRIBUTARY OF THE LOWER ST. LAWRENCE ESTUARY.
Institut Maurice-Lamontagne, Mont-Joli (Quebec).
Y. de Lafontaine.
Estuaries ESTUDO, Vol. 13, No. 1, p 43-50, March 1990. 2 fig, 4 tab, 42 ref.

Descriptors: *Estuaries, *Estuarine fisheries, *Plankton, *Saline-freshwater interfaces, *Species composition, *St Lawrence Estuary, Spawning, Water circulation.

The species composition and relative abundance of ichthyoplankton were investigated during summer 1986 at four stations along the salinity gradient in the Manicouagan River estuary, a tributary of the lower St. Lawrence estuary. Physical characteristics of the water masses indicated the presence of a strong saline front (>10 ppt per km) delineating the freshwater and marine section of the Manicouagan estuary. The estuary supports a depauperate ichthyoplankton community, including four species of pelagic fish eggs and eight species of fish larvae. Species richness increased with salinity. The ichthyoplankton fauna can be divided into two distinct groups: freshwater and marine. These two groups result initially from spawning preferences exhibited by the different species and remain discrete due to the presence of the saline front limiting the upstream intrusion of marine larvae. The abundance of freshwater larvae was maximal at the head of the estuary and marine larvae were most abundant at the most saline station. The length frequency distribution suggests that marine larvae are not effectively retained within the estuary. The Manicouagan estuary cannot be considered as a major spawning site nor an important nursery zone for any fish found in this area. (Author's abstract)
W90-09043

PATTERNS OF ESTUARINE USE BY JUVENILE ENGLISH SOLE (PAROPHRYS VETULUS) AND DUNGENESS CRAB (CANCER MAGISTER).
Washington Univ., Seattle. School of Fisheries.
D. G. Gunderson, D. A. Armstrong, Y. B. Shi, and R. A. McConnaughey.
Estuaries ESTUDO, Vol. 13, No. 1, p 59-71, March 1990. 9 fig, 2 tab, 60 ref. Washington Sea Grant NA 86AA-D-SG044, U.S. Army Corps of Engineers Grant DACW 67-85-0033.

Descriptors: *Crabs, *Estuaries, *Estuarine environment, *Estuarine fisheries, *Fish behavior, *Growth, Crustaceans, Sole, Washington.

Extensive trawl surveys were conducted in two large estuaries (Grays Harbor and Willapa Bay) on the Washington coast during 1983-1987, and in adjacent areas of open coast. These surveys have shown that both English sole and Dungeness crab rely heavily in these estuaries as nursery areas, although the pattern of utilization differs substantially. Juvenile migration patterns can show substantial interannual variability and can only be delineated by concurrent surveys in both coastal and estuarine areas, conducted over a period of several years. English sole eggs and Dungeness crab larvae are released in coastal waters. Larvae of both species transform to the benthic stage in both coastal and estuarine areas, but most English sole eventually migrate into the estuaries during the first year of life, even if initial settlement is along the open coast. By the time English sole have attained a length of 55 mm (TL), most of them are found in estuaries. English sole begin emigrating from the estuaries at about 75 mm, and few remain there during the second year of life. Growth is substantially faster in estuaries where 0+ crab reach a mean size of about 40 mm carapace width (CW) by September, with those off the coast are only about 14 mm CW. Juveniles remain

in the areas of settlement over their first winter but, in contrast to the English sole, most coastal 1+ crab immigrate to estuaries to join siblings that settled there the previous year. By September of the second year, crab at about 100 mm CW emigrate to the open coast where they reach maturity. Advantages to juvenile stages that reside in estuaries include accelerated growth at higher temperatures and potentially greater food supplies than found nearshore along the coast. (Author's abstract)
W90-09044

FATE OF PETROLEUM HYDROCARBONS AND TOXIC ORGANICS IN LOUISIANA COASTAL ENVIRONMENTS.
Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments.
For primary bibliographic entry see Field 5B.
W90-09045

LABORATORY SIMULATION OF DIFFUSION IN CONTAMINATED MARINE SEDIMENTS.
Louisiana State Univ., Baton Rouge. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5B.
W90-09046

CONTAMINANTS IN SEDIMENTS FROM THE CENTRAL GULF OF MEXICO.
Gulf Coast Research Lab., Ocean Springs, MS.
For primary bibliographic entry see Field 5B.
W90-09048

AMMONIA NITROGEN IN THE BLACK SEA (IN RUSSIAN).
For primary bibliographic entry see Field 5B.
W90-09060

DISSOLVED MANGANESE IN THE NORTH-EASTERN ATLANTIC OCEAN (IN RUSSIAN).
For primary bibliographic entry see Field 2K.
W90-09061

ORGANIC CARBON AND FORMATION OF ORGANIC MATTER IN GULFS OF THE WHITE SEA (IN RUSSIAN).
For primary bibliographic entry see Field 2K.
W90-09062

IMPACTS OF CLIMATIC CHANGES ON HYDROLOGY AND WATER RESOURCES OF COASTAL ZONES.
IHP-National Committee, 106 Westlaan, 2641 DP Pijnacker, The Netherlands.
For primary bibliographic entry see Field 2A.
W90-09097

IMPACT OF SEA LEVEL RISE ON COASTAL ZONE MANAGEMENT IN SOUTHERN SWEDEN.
Lund Univ. (Sweden). Dept. of Water Resources Engineering.
For primary bibliographic entry see Field 2A.
W90-09098

IMPACT OF CLIMATE CHANGE ON COASTAL ZONE MANAGEMENT IN BRITAIN: A PRELIMINARY ANALYSIS.
Middlesex Polytechnic, London (England). Flood Hazard Research Centre.
For primary bibliographic entry see Field 2A.
W90-09099

PRACTICAL APPLICATION OF THEORY FOR TIDAL-INTRUSION FRONTS.
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 8I.
W90-09127

INVESTIGATION OF COPPER COMPLEXATION IN THE SEVERN ESTUARY USING DIF-
FERENTIAL PULSE CATHODIC STRIPPING VOLTAMMETRY.
Water Research Centre, Medmenham (England).
For primary bibliographic entry see Field 5B.
W90-09128

CYCLING OF IODINE AS IODATE AND IODIDE IN A TROPICAL ESTUARINE SYSTEM.
Pontificia Univ. Catolica do Rio de Janeiro (Brazil). Dept. de Quimica.
A. DeLuca Rebello, F. W. Herms, and K. Wagener.
Marine Chemistry MRCHBD, Vol. 29, No. 1, p 77-93, March 1990. 2 fig, 7 tab, 25 ref.

Descriptors: *Cycling nutrients, *Estuaries, *Iodine, *Seawater, *Tropical regions, Bays, Diurnal variation, Minerals, Models, Photosynthesis, Phytoplankton, Respiration, Sediment transport.

The concentration of iodate and iodide were independently determined in seawater samples from Guanabara Bay (Rio de Janeiro, Brazil) taken at depths from 0.15 to 5 m (which was almost the bottom), at various times of the day and in three different seasons (May, July, and November) representing both the wet and dry seasons. The ratio of the two species varied between 0.3 and 3.9, and their concentrations changed at rates on the order of 10 micromoles/hr. This was about two orders of magnitude faster than can be expected from fluxes from sediments. These rates of variation were highly correlated with rates of photosynthesis and respiration, and concentration of phytoplankton. A model was formulated which explained the diurnal cycling of iodine by biological activity in agreement with the observed phenomena. Using the model, turnover rates were calculated which were about 40 times higher than diffusion-controlled reactions (release from sediments) suggesting these fluxes were of a biological nature. (Geiger-PTT)
W90-09129

NATURAL VARIABILITY IN PHOTOSYNTHETIC ENERGY CONVERSION EFFICIENCY: A FIELD STUDY IN THE GULF OF MAINE.
Brookhaven National Lab., Upton, NY. Oceanographic Sciences Div.
Z. Kolber, K. D. Wyman, and P. G. Falkowski.
Limnology and Oceanography LIOCAH, Vol. 35, No. 1, p 72-79, January 1990. 4 fig, 37 ref.

Descriptors: *Estuarine environment, *Gulf of Maine, *Limiting nutrients, *Photosynthesis, *Phytoplankton, Bays, Fluorescence, Fluorometry, Growth rates, Gulfs, Nitrogen.

The maximal change in the quantum yield of fluorescence is a quantitative measure of photosynthetic conversion efficiency of phytoplankton. Using a pump-and-probe fluorometer, the maximal change in the quantum yield of fluorescence was measured along the 100-m isobath in the Gulf of Maine in June 1987. The hydrographic regime was characterized by a nutrient-rich, vertically mixed region in the northeast and a nutrient-depleted, stratified region to the southwest. The results reveal that the maximal change in the quantum yield of fluorescence is strongly related to the rate of supply of dissolved inorganic nitrogen and provide strong evidence that photosynthetic energy conversion can be nutrient limited in natural phytoplankton communities. (Author's abstract)
W90-09145

SIZE-FRACTIONATED MEASUREMENTS OF NITROGEN UPTAKE IN AGED UPWELLED WATERS: IMPLICATIONS FOR PELAGIC FOOD WEBS.
Cape Town Univ. (South Africa). Dept. of Oceanography.
T. A. Probyn, H. N. Waldron, and A. G. James.
Limnology and Oceanography LIOCAH, Vol. 35, No. 1, p 202-210, January 1990. 5 fig, 2 tab, 36 ref.

Descriptors: *Ammonia, *Food chains, *Marine animals, *Marine plants, *Nitrates, *Upwelling, *Ureas, Chlorophyll, Model studies, Nutrients, Particle size, Phytoplankton, Surface water, Zooplankton.

Uptake of NO3(-), NH4(+), and urea was measured for the 200-20-, 20-2-, and <2-micron size classes within the chlorophyll maximum layer in the Benguela upwelling system. Picoplankton and nanoplankton dominated in terms of biomass and activity both inshore and offshore. Net plankton N uptake declined drastically at night, whereas the smaller size classes maintained rates close to daytime levels. There was some evidence for N resource partitioning. Reduced N generally made up a higher proportion of the total N uptake by nanoplankton and picoplankton (for both size classes, mean = 94%) than by net plankton (mean = 63%). The contribution of nanoplankton and picoplankton NH4(+) uptake always exceeded 50% of the total primary N production. In a regeneration-based model with small cells dominating primary production it is conservatively estimated that carnivory on microzooplankton can contribute 14% toward the production of an omnivorous mesozooplankton assemblage. (Author's abstract)
W90-09151

PREDICTING THE VERTICAL STRUCTURE OF TIDAL CURRENT AND SALINITY IN SAN FRANCISCO BAY, CALIFORNIA.
California State Dept. of Water Resources, Sacramento.
M. Ford, J. Wang, and R. T. Cheng.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 1027-1045, May 1990. 11 fig, 1 tab, 35 ref.

Descriptors: *California, *Estuaries, *Model studies, *Salinity, *San Francisco Bay, *Tidal currents, Channels, Hydrodynamics, Mathematical studies, Mixing, Salinity currents, Stratification, Water circulation.

A two-dimensional laterally averaged numerical estuarine model was developed to study the vertical variations of tidal hydrodynamic properties in the central/north part of San Francisco Bay, California. Useful features of previous laterally averaged models were incorporated into the model development. Vertical variations were mainly present in the deep channels. Tidal stage data, current meter measurements, and conductivity, temperature, and depth profiling data in San Francisco Bay were used for comparison with model predictions. A sigma plane transformation was used in the vertical dimension to alleviate problems associated with fixed grid model applications in the bay, where the tidal range can be as much as 20-25% of the total water depth. Calibration and verification were conducted at low and high freshwater discharges. Model predictions of tidal stage and velocity compared favorably with the available field data and prototype salinity stratification was qualitatively reproduced. During periods of high freshwater discharges, pushing of the freshwater interface downstream and suppression of vertical mixing tended to develop highly stratified salinity distributions in the lower reaches of the central/north bay. During low freshwater discharges, the freshwater interface moved upstream, and vertical mixing increased with reduced vertical salinity gradients. (Cassar-PTT)
W90-09174

BIOMASS AND RESOURCE ALLOCATION OF TYPHA ANGUSTIFOLIA L. (TYPHACEAE): THE EFFECT OF WITHIN AND BETWEEN YEAR VARIATIONS IN SALINITY.
Smithsonian Environmental Research Center, Edgewater, MD.
D. F. Whigham, E. E. Jordan, and J. Miklas.
Bulletin of the Torrey Botanical Club BTBCAL, Vol. 116, No. 4, p 364-370, October/December 1989. 6 fig, 29 ref. NSF Grants DEB-7911563, CEE-82-19615, and BSR-83-16948.

Descriptors: *Biomass, *Cattails, *Estuaries, *Marshes, *Salinity, *Wetlands, Aquatic plants, Brackish water, Chesapeake Bay, Macrophytes, Marsh plants, Plant growth, Rivers, Tidal rivers.

In a brackish wetland dominated by Typha angustifolia, similar aboveground and belowground production at three sites with very different salinity regimes. The sites, located on the Rhode River, a small subestuary of the Chesapeake Bay, included (1) an upstream area 200 m from a freshwater forested wetland, (2) a downstream area 100 m from the ecotone with the brackish high marsh, and (3) a middle area halfway between. Mean salinities between Julian days 110 and 190 for 1980-1988 were as follows: upstream, up to 5 ppt; downstream, 2-9 ppt; middle, 0.5-8 ppt. There were significant differences between the three areas in shoot density, height, and biomass. Density was greatest in the downstream site while height and biomass were greatest at the lower salinity sites. At the site with highest salinity, roots and rhizomes were restricted to shallower depths. Interannual differences were studied in the middle area for several years. When salinity was high in 1985, shoot density, height, biomass, and number of reproductive shoots were significantly less than in low salinity years; the difference in the net aboveground biomass was 75%. (Cassar-PTT)
W90-09186

CADMIUM BIOACCUMULATION IN ORGANS OF THE SCALLOP MIZUHOPECTEN YESSOENSIS.
Akademiya Nauk SSSR, Vladivostok. Inst. Biologii Morya.
For primary bibliographic entry see Field 5B.
W90-09196

IMPORTANCE OF GRAZING ON THE SALT-MARSH GRASS SPARTINA ALTERNIFLORA TO NITROGEN TURNOVER IN A MACROFAUNAL CONSUMER, LITTORINA IRRORATA, AND TO DECOMPOSITION OF STANDING-DEAD SPARTINA.
Brookhaven National Lab., Upton, NY. Oceanographic Sciences Div.
P. F. Kemp, S. Y. Newell, and C. S. Hopkinson.
Marine Biology MBIOAJ, Vol. 104, No. 2, p 311-319, February 1990. 3 fig, 2 tab, 41 ref. National Science Foundation Grant BSR-86-04653.

Descriptors: *Estuarine environment, *Grazing, *Marsh plants, *Marshes, *Nitrogen cycle, *Salt marshes, Biodegradation, Decomposition, Degradation, Detritus, Gastropods, Georgia, Nitrogen, Periwinkles, Sapelo Island, Snails, Spartina.

Nitrogen assimilation from living and standing-dead Spartina alterniflora by Littorina irrorata Say, a periwinkle, was studied by labelling plants with nitrogen-15 and measuring the transfer into grazing snails in Sapelo Island salt marshes. The initial label of about 8% total plant nitrogen declined to about 1% over 5 months, perhaps due to label dilution by less enriched nitrogen taken up and translocated from belowground to aboveground Spartina biomass. Snails incorporated Spartina-derived N into tissues at rates equal to 10 to 20% of total snail nitrogen per 30 days in summer and fall, and 2 to 5% per 30 days in winter. The annual total assimilation of Spartina-derived N was equal to the Littorina-N biomass. Assimilation of nitrogen in the presence of living Spartina material was reduced substantially below that in the presence of intact plants (living and dead material present). It was concluded that grazing may have little impact on the early stages of decomposition of the bulk of the shoots that senesce later in fall, but may be important in the later stages of decomposition of dead shoots persisting through winter. (Cassar-PTT)
W90-09198

DISPERSAL OF SUSPENDED MATTER IN MAKASAR STRAIT AND THE FLORES BASIN.
Nederlands Inst. voor Onderzoek der Zee, Texel.
E. Eisma, J. Kalf, M. Karmini, W. G. Mook, and A. van Put.
Netherlands Journal of Sea Research NJSRBA, Vol. 24, No. 4, p 383-398, December 1989. 13 fig, 1 tab, 10 ref.

Descriptors: *Estuaries, *Rivers, *Sedimentation, *Suspended sediments, Deposition, Flores Basin,

Indonesia, Mahakam River, Makasar Strait, Organic matter, Particle size, Volcanoes, Water circulation.

Sampling of water (for temperature, salinity, dissolved oxygen, and carbon dioxide), bottom sediments (for sediment composition), and suspended matter (for particle composition and size) was conducted in the Makasar Strait and Flores Basin in Indonesia. A sediment trap was moored in the Flores Basin at 4600 m depth for 4 months of the dry season. In the Flores Basin, bottom flow was present, resuspending material and preventing suspended material from settling. In the Makasar Strait, deep water inflow from the south and north resulted in very slow bottom water flow. Bottom deposits in both areas were predominantly terrigenous, a mixture of organic carbonate and silica. Volcanic material was present near the volcanoes in the south. No volcanic particles and small amounts of planktonic material were found in the suspended matter, although plankton accounted for 10-15% of the top sediment and of the material deposited in the sediment trap. Suspended particles containing tin and iron were detected. These were derived from northern Kalimantan or northern Sulawesi. Suspended matter concentrations were generally less than 0.5 mg/cu dm; however, near the Mahakam River mouth concentrations were >1 mg/cu dm. Particle size was erratic because of the variable composition of the coarser particles in suspension. Organic matter concentrations in suspension roughly followed the distribution of suspended matter, but organic content of the suspended matter did not show any trends. All suspended organic matter was of marine origin except in the river and estuary. Deposition rates (in mg/sq cm/yr) were 150 for total sediment, 26 for carbonate, 13 for organic matter, and 111 for inorganic material. Flocs and fibers in suspension were found in and below the Mahakam River plume that reaches about 400 km from the river mouth to the southeast and in surface waters associated with plankton. The flocs were related to particle concentration, turbulence, and the presence or organisms producing sticky material. (Cassar-PTT)
W90-09200

SIMULATION OF THE DIAGENESIS OF CARBON, SULFUR, AND DISSOLVED OXYGEN IN SALT MARSH SEDIMENTS.
South Carolina Univ., Columbia. Belle W. Baruch Inst. for Marine Biology and Coastal Research.
For primary bibliographic entry see Field 2J.
W90-09208

OIL SPILLAGE IN ANTARCTICA: INITIAL REPORT OF THE NATIONAL SCIENCE FOUNDATION-SPONSORED QUICK RESPONSE TEAM ON THE GROUNDING OF THE BAHIA PARAISO.
Texas A and M Univ., College Station.
For primary bibliographic entry see Field 5C.
W90-09216

STUDY OF COPPER(II) ASSOCIATION WITH DISSOLVED ORGANIC MATTER IN SURFACE WATERS OF THREE MEXICAN COASTAL LAGOONS.
Stanford Univ., CA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-09218

RESIDUAL CIRCULATION IN SHALLOW ESTUARIES: 1. HIGHLY STRATIFIED, NARROW ESTUARIES.
Washington Univ., Seattle. Geophysics Program.
D. A. Jay, and J. D. Smith.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 95, No. 1, p 711-731, January 15, 1990. 11 fig, 33 ref, NSF Grants OCE-8208856, OCE-8504237, OCE-8711790.

Descriptors: *Columbia River Estuary, *Estuaries, *Residual flow, *Saline-freshwater interfaces, *Tidal amplitude, *Tidal currents, *Tides, *Turbulent flow, *Water circulation, Harmonic analysis, Long-wave theory, Mathematical equations, Model studies, River flow, Stratified estuaries, Tidal waves.

Long-wave theory and simple turbulence closures were used to show that three distinct types of circulation (highly stratified, weakly stratified, and partially mixed) arise in narrow, shallow estuaries from the finite amplitude of the tide and the interaction of stratification with vertical mixing. Each type has a different dominant process causing the vertical exchange of salt and fresh water on the flood, and each gives rise to a characteristic residual circulation. The tidal circulation in highly stratified shallow estuaries is the result of a finite amplitude internal motion driven by the barotropic tide; shear instabilities at the interface are the major vertical exchange mechanism. The residual circulation is caused primarily by ebb-flood asymmetry in interface position and thickness. A model based on our theoretical analysis showed that the interface thickness on flood was much less than the depth of flow up to a critical tidal amplitude at which the two-layer flow is destroyed, and correctly predicted the tidal amplitude of the neap-spring transition in the Columbia River Estuary. Tidal frequency internal wave motion was not found in weakly stratified and partially mixed estuaries. Because of the reduced tidal shear, shear instabilities are weak or absent, and the residual circulation assumes a very different character. (See also W90-09224) (Author's abstract)
W90-09223

RESIDUAL CIRCULATION IN SHALLOW ESTUARIES: 2. WEAKLY STRATIFIED AND PARTIALLY MIXED, NARROW ESTUARIES.
Washington Univ., Seattle. Geophysics Program.
D. A. Jay, and J. D. Smith.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 95, No. 1, p 733-748, January 15, 1990. 6 fig, 34 ref, NSF Grants OCE-8208856, OCE-8504237, OCE-8711790.

Descriptors: *Columbia River Estuary, *Estuaries, *Mathematical models, *Model studies, *Residual flow, *Saline-freshwater interfaces, *Tidal amplitude, *Tides, *Turbulent flow, *Water circulation, Long-wave theory, Mathematical equations, River flow, Stratified estuaries, Tidal waves.

Long-wave theory was used to analyze circulation in weakly stratified and partially mixed estuaries. Unlike the highly stratified systems, the flows have only a minimal tidal-frequency internal wave component. These estuaries may therefore be modeled as the sum of weakly interacting barotropic and baroclinic modes. The dominant factors driving the residual flow are finite amplitude barotropic effects in weakly stratified estuaries and a combination of barotropic effects and steady horizontal density gradient forcing in partially mixed estuaries. The dominant vertical exchange mechanism in the weakly stratified case is bottom boundary-induced turbulence, and that in partially mixed estuaries is believed to be random internal wave interactions. A model of the Columbia River Estuary under weakly stratified conditions accurately predicted the observed residual velocity and salinity fields, and the tidal amplitude at which a transition to a highly stratified state takes place. This model also correctly predicted the critical tidal amplitude at which the system returns to a highly stratified state after the spring tide. The partially mixed state is unstable in the Columbia River Estuary because the tides and buoyancy input are both too strong. As soon as turbulent mixing is suppressed in the interior during periods of decreasing tidal forcing, the system again becomes highly stratified. Conversely, whenever internal mixing by Kelvin-Helmholtz instabilities destroys the two layer flow during periods of increasing tidal range, bottom boundary-induced turbulent mixing can penetrate throughout the flow, allowing the establishment of a weakly stratified system. (See also W90-09223) (Author's abstract)
W90-09224

SPATIAL AND TEMPORAL PATTERNS IN STRUCTURE OF MACROBENTHIC ASSEMBLAGES. A THREE-YEAR STUDY IN THE NORTHERN ADRIATIC SEA IN FRONT OF THE PO RIVER DELTA.
Ente Nazionale per l'Energia Elettrica, Milan

Group 2L—Estuaries

(Italy). Centro Termica e Nucleare.
For primary bibliographic entry see Field 2H.
W90-09225

ZONATION AND ECOLOGY OF EPIPHYTIC HYDROIDS IN A MEDITERRANEAN COASTAL LAGOON: THE 'STAGNONE' OF MARSALA (NORTH-WEST SICILY).
Istituto Sperimentale Talassografico 'Attilio Cerruti', Taranto (Italy).
For primary bibliographic entry see Field 2H.
W90-09226

SEASONAL CHANGES IN PORE WATER CONCENTRATIONS OF NUTRIENTS AND THEIR DIFFUSIVE FLUXES AT THE SEDIMENT-WATER INTERFACE.
Centre d'Etudes d'Oceanographie et de Biologie Marine, Roscoff (France).
For primary bibliographic entry see Field 2K.
W90-09242

EFFECTS OF NUTRIENT ENRICHMENT ON NATURAL POPULATIONS OF THE BROWN TIDE PHYTOPLANKTON AUREOCOCCUS ANOPHAGEFFERENS (CHRYSOPHYCEAE).
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
A. A. Keller, and R. L. Rice.
Journal of Phycology JPYLAJ, Vol. 25, No. 4, p 636-646, December 1989. 8 fig, 2 tab, 31 ref. EPA cooperative agreement CR-81247-01.

Descriptors: *Algal blooms, *Algal growth, *Aureococcus, *Bays, *Marine algae, *Narragansett Bay, *Picoalgae, *Rhode Island, Brown tide, Diatoms, Limiting nutrients, New Jersey, New York, Nitrogen.

The phytoplankton community in Narragansett Bay, Rhode Island was dominated by an unusual bloom of the brown tide picoalga, Aureococcus anophageffferens during early summer, 1985. This previously unrecognized chrysophyte reached a maximum concentration of about 2,000,000,000 cells/L in Narragansett Bay, with similar high densities simultaneously reported in Long Island embayments, New York and Barnegat Bay, New Jersey. The brown tide picoalga was present in approximately equal numbers in 12 large scale (13,000 L) mesocosms at the start of a nutrient addition experiment in June 1985. Increases in abundance in untreated systems mimicked the pattern of bloom development in Narragansett Bay, the seawater source for the experiment. Aureococcus increased to maximal values of 2,600,000,000 cells/L and persisted at high numbers for 7-8 weeks. In nutrient addition tanks, the picoalgae bloomed briefly (1-3 weeks) but rapidly declined to the usual level (about 10,000,000 cells/L for eukaryotic algae in Narragansett Bay). The decline in picoalgae abundance was followed by an increase in total diatoms in all nutrient treated tanks. Mean picoalgae abundance in the mesocosms and the bay was significantly and inversely correlated with mean concentration of dissolved inorganic nitrogen. The persistence of the brown tide species in control mesocosms and Narragansett Bay appears related to its ability to grow at very low concentrations of dissolved inorganic nitrogen, levels previously shown to limit diatom growth. (Mertz-PTT)
W90-09243

LIPOPHILIC PIGMENTS FROM CYANOBACTERIAL (BLUE-GREEN ALGAL) AND DIATOM MATS IN HAMELIN POOL, SHARK BAY, WESTERN AUSTRALIA.
National Aeronautics and Space Administration, Moffett Field, CA. Ames Research Center.
A. C. Palmisano, R. E. Summons, S. E. Cronin, and D. J. Des Marais.
Journal of Phycology JPYLAJ, Vol. 25, No. 4, p 655-661, December 1989. 7 fig, 4 tab, 30 ref.

Descriptors: *Australia, *Carotenoids, *Chlorophyll, *Cyanophyta, *Lipophilic pigments, *Pigments, Bacteria, Bays, Chlorophyll a, Cyanobacteria, Diatoms, Paleolimnology, Shark Bay.

Lipophilic pigments were examined in microbial mat communities dominated by cyanobacteria in the intertidal zone and by diatoms in the subtidal and sublittoral zones of Hamelin Pool, Shark Bay, Western Australia. These microbial mats have evolutionary significance because of their similarity to lithified stromatolites from the Proterozoic and Early Paleozoic eras. Fucoxanthin, diatoxanthin, diadinoxanthin, beta-carotene, and chlorophylls a and c characterized the diatom mats, whereas cyanobacterial mats contained myxoxanthophyll, zeaxanthin, echinenone, beta-carotene, chlorophyll a and in some cases, sheath pigment. The presence of bacteriochlorophyll a within the mats suggests a close association of photosynthetic bacteria with diatoms and cyanobacteria. The high carotenoids:chlorophyll a ratios (0.84-2.44 wt/wt) in the diatom mats suggest that carotenoids served a photoprotective function in this high light environment. By contrast, cyanobacterial sheath pigment may have largely supplanted the photoprotective role of carotenoids in the intertidal mats. (Author's abstract)
W90-09244

ANTIBIOTIC RESISTANCE OF SALMONELLA STRAINS ISOLATED FROM NATURAL POLLUTED WATERS.
Malaga Univ. (Spain). Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W90-09274

RARE EARTH ELEMENTS IN RIVERS, ESTUARIES, AND COASTAL SEAS AND THEIR SIGNIFICANCE TO THE COMPOSITION OF OCEAN WATERS.
Cambridge Univ. (England). Dept. of Earth Sciences.
For primary bibliographic entry see Field 2K.
W90-09292

GEOCHEMISTRY OF DISSOLVED PHOSPHATE IN THE SEPIK RIVER AND ESTUARY, PAPUA, NEW GUINEA.
Harvard Univ., Cambridge, MA. Dept. of Earth and Planetary Sciences.
For primary bibliographic entry see Field 2K.
W90-09293

MICROPHYTOBENTHIC PIGMENTS IN A SALT MARSH POND DETERMINED BY HPLC AND SPECTROPHOTOMETRY.
IFREMER, Paris (France).
For primary bibliographic entry see Field 7B.
W90-09294

TEMPORAL AND SPATIAL VARIATIONS IN IRON CONCENTRATIONS OF TROPICAL BIVALVES DURING A DREDGING EVENT.
Newcastle upon Tyne Univ. (England). Dept. of Biology.
B. E. Brown, and A. J. Kumar.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 3, p 118-123, 1990. 4 fig, 1 tab, 26 ref. Natural Environment Research Council grant GR/5857.

Descriptors: *Bioindicators, *Dredging, *Intertidal areas, *Iron, *Mollusks, *Pollutant identification, *Tropical regions, *Water pollution, Mine wastes, Reefs, Thailand, Tin, Tissue analysis, Water pollution sources.

Shellfish are valuable biological indicators of metal pollution. Tissue iron concentrations in the tropical bivalves Saccostrea cucullata and Isognonmon collected from three sites around Ko Phuket, Thailand were significantly negatively correlated with body weight. The study sites were on the intertidal reef flats. Site A was a bay with a tin-ore dressing plant, adjacent to a tin-smelter. Site B was a bay with an intertidal reef, but no direct effluent discharge from industry. Site C was also an intertidal reef, but with a westerly aspect, being subject to the south-west monsoon influence. The relationship between metal concentration and body weight differs with respect to location, with highest iron levels being recorded in bivalves living in the vicinity of a tin-ore dressing plant. Temporal ele-

vations in bivalve iron concentrations closely parallel times of dredging activity and iron effluent discharge. The effect of body size on iron concentrations was investigated in both shellfish species by using linear regression analysis of logarithmic transformed data. A negative relationship between body size and iron concentrations was significant for both species. (Mertz-PTT)
W90-09296

CONDITIONS OF THE PERACARID POPULATIONS OF SUBTIDAL COMMUNITIES IN NORTHERN BRITANNY TEN YEARS AFTER THE AMOCO CADIZ OIL SPILL.
Centre d'Etudes d'Oceanographie et de Biologie Marine, Roscoff (France).
For primary bibliographic entry see Field 5C.
W90-09297

POLLUTION EFFECTS ON THE STRUCTURE OF MEIOFAUNAL COMMUNITIES IN THE BAY OF NAPLES.
Naples Univ. (Italy). Dipt. Genetica, Biologia Generale e Molecolare.
For primary bibliographic entry see Field 5A.
W90-09300

BASIC CHARACTERISTICS OF THE TIDAL FLAT ON THE NORTH COAST OF HANGZHOU BAY (IN CHINESE).
East China Normal Univ., Shanghai. Inst. of Estuarine and Coastal Research.
P. Cao, Y. Dong, S. Yan, and G. Gu.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 20, No. 5, p 412-421, 1989. 10 fig, 3 tab, 4 ref. English summary.

Descriptors: *China, *Estuaries, *Hangzhou Bay, *Sediment transport, *Tidal flats, Coastal areas, Erosion, Sedimentation.

The tidal flat on the north coast of Hangzhou Bay which runs from Nanhui Point in the east to Ganpu in the west was formed under the dynamic action of large tidal currents and high velocity waves. Sediments on the north coast of Hangzhou Bay come mainly from the Changjiang estuary. Longitudinal sediment transport along the coast is restricted by the boundary conditions, changing the flat through the processes of erosion and sedimentation. Due to the transverse diffusion of sediments in the formation of the tidal flats, the sediments are transported toward the banks. Therefore, the sediment grain size distribution is generally from coarse to fine. The tidal flat on the north of Hangzhou Bay is, in general, the product of longitudinal and transverse movement of sediments. (Author's abstract)
W90-09328

STUDIES ON SEDIMENTARY PHOSPHATE IN RECENT SEDIMENTS OF THE ZHUJIANG RIVER ESTUARY.
Academia Sinica, Qingdao (China). Inst. of Oceanology.
X. Lan.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 20, No. 5, p 480-487, September 1989. 2 fig, 6 tab, 10 ref.

Descriptors: *China, *Phosphates, *Salinity, *Sediment chemistry, Calcium, Estuaries, Iron, Zhujiang River.

The Zhujiang river estuary is located in a subtropical zone. A systematic analysis of recent sediment samples has revealed that sedimentary phosphate can be used to distinguish the salinity changes of sedimentary environments and can be an indicator of sedimentary facies. The change in the ratio of $Ca/(Ca + Fe)$ in recent sedimentary phosphate in the Zhujiang river estuary is in agreement with the changes in other recent sedimentary environments. This implies that the ratio of $Ca/(Ca + Fe)$ in sedimentary phosphate does reflect to some extent the paleoenvironment and paleosalinity. The salinity value (S ppt) evaluated by Nelson's salinity quantitative formula for the Zhujiang river estuary

is relative to the relationship of bottom layer salinity, which indicates that S ppt is somewhat high when the ratio of Ca/(Ca + Fe) is lower, but low when the ratio of Ca/(Ca + Fe) is higher. (Author's abstract)
W90-09331

SPECIATION OF TIN IN SEDIMENTS OF ARCACHON BAY (FRANCE).
Universite de Pau et des Pays de l'Adour (France). Lab. de Chimie Analytique.
For primary bibliographic entry see Field 5B.
W90-09392

EFFECTS OF THE INSECTICIDE METHOMYL ON DEVELOPMENT AND REGENERATION IN MEGALOPA AND JUVENILES OF THE MUD CRAB, RHITHROPANOPEUS HARRISII (GOULD).
Duke Univ., Beaufort, NC. Marine Lab.
For primary bibliographic entry see Field 5C.
W90-09441

BIOLOGICAL IMPACT OF WOOD TREATED WITH CHROMATED COPPER ARSENATE ON SELECTED ESTUARINE ORGANISMS.
New Jersey Medical School, Newark. Dept. of Anatomy.
For primary bibliographic entry see Field 5C.
W90-09442

USE OF GRASS SHRIMP (PALAEMONETES PUGIO) LARVAE IN FIELD BIOASSAYS OF THE EFFECTS OF AGRICULTURAL RUNOFF INTO ESTUARIES.
Duke Univ., Beaufort, NC. Marine Lab.
For primary bibliographic entry see Field 5A.
W90-09443

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

DISTILLATION IRRIGATION: A LOW-ENERGY PROCESS FOR COUPLING WATER PURIFICATION AND DRIP IRRIGATION.
Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 3F.
W90-09365

3B. Water Yield Improvement

CLOUD SEEDING, DATA COLLECTION AND ANALYSIS ASSOCIATED WITH THE COLORADO RIVER AUGMENTATION DEMONSTRATION PROGRAM, 1985-86 SEASON.
North American Weather Consultants, Salt Lake City, UT.
J. R. Thompson.
Available from the National Technical Information Service, Springfield, VA. 22161. NAWC Report WM 86-7, December 1986. 109p, 3 fig, 15 tab, 6 ref, append. Bureau of Reclamation Contract 5-CR-81-05090.

Descriptors: *Cloud seeding, *Colorado River, *Flow augmentation, *Meteorological data collection, *Weather modification, Cloud liquid water, Colorado, Data acquisition, Data collections, Grand Mesa, Network design, Radiometry, Silver iodide.

Limited experimental cloud seeding was conducted for the first time as a part of the Colorado River Augmentation Demonstration Program (CRADP) during the 1985-86 winter season. The cloud seeding occurred over the Grand Mesa region of western Colorado. Seeding activities, which included aerial and ground releases of silver-iodide-ammonium iodide--acetone, were associated with three research studies, i.e., microphysical experiments,

transport and dispersion of seeded plumes, and systems reliability testing of a new prototype cloud seeding generator. Results obtained from the climatological studies from one winter season (about two months) of cloud seeding have clearly demonstrated that not only is the Grand Mesa an ideal place to conduct weather modification research, but also appears to be a very suitable laboratory that contains an atmosphere which is amenable to cloud seeding effects. More data needs to be acquired from a larger sample of meteorological conditions to provide the sort of information needed to improve cloud seeding technology in the Colorado River Basin. Several transport and dispersion (T and D) studies were made during the 1985-86 field season which have provided valuable information about the action of seeding plumes released from the ground, or an aircraft. Ground released plumes were frequently observed to reach an altitude two thousand feet above the Mesa top, suggesting that ground seeding would be an effective delivery system. Measurements of liquid water, made with a microwave radiometer, have documented the frequent occurrence of liquid water in association with 700 mb wind flow from the south or southwest. Data from the icing rate meters at Rapid Creek and the WAPA tower substantiate that liquid water is most frequently observed with 'southerly' flow but not to the extent the radiometer data suggests. The icing rate meter data clearly indicates the highest per hour average (in g/cu m) occurs with 'northerly' flow. There is some question as to the validity of the radiometer data with northerly flow since air passing over the radiometer is in a descending mode and is losing liquid water. A specific recommendation would be to locate the radiometer on top of the Mesa to acquire the most representative liquid water measurements possible. (Lantz-PTT)
W90-08754

PREDICTION OF ANNUAL WATER YIELD FROM LAND MANAGEMENT ACTIVITIES.
Colorado State Univ., Fort Collins.
J. D. Stednick, and D. F. Potts.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 61-626, 6 fig, 1 tab, 11 ref.

Descriptors: *Headwaters hydrology, *Land management, *Model studies, *Water yield improvement, Instream flow, Land use, Precipitation, Vegetation, Water use, Water yield.

Wildland management often involves vegetation manipulation that increases annual water yield. In some regions of the western U.S., increased water yield is often a forest management target, as total water yield, instream flow requirement or other downstream user need. In other regions of the west, management objectives may be to limit water yield increases for the protection of stream channel stability and fisheries. In either regard, quantification of water yield increases from vegetation removal are necessary, and hydrologic models must be used. WATBAL is a model that was designed for hydrologic regimes dominated by snowfall and is therefore appropriate for use in most of the higher-elevation western United States. It was adopted and modified from its original data-intensive format for use in the WRENSS procedures. This paper presents a sensitivity analysis of the WRENSS version of WATBAL. The analysis includes a comparison of observed and predicted annual water yield from managed and unmanaged watersheds on the Fraser Experimental Forest in Colorado to determine required accuracy of input parameters. Results indicate that accurate prediction of annual water yield requires accurate precipitation measurements. WATBAL predictions are not sensitive to vegetation species or pre-disturbance stand characteristics. Evaluation of model sensitivity to input parameters identifies opportunities for model improvement, and suggests reevaluation of 'target' water yield accuracy. (See also W90-08822) (Author's abstract)
W90-08884

MANAGEMENT OF BASEFLOW AUGMENTATION: A REVIEW.
San Diego State Univ., CA. Dept. of Civil Engineering.
V. M. Ponce, and D. S. Lindquist.
Water Resources Bulletin WARBAQ, Vol. 26, No. 2, p 259-268, April 1990. 30 ref.

Descriptors: *Base flow, *Base-flow augmentation, *Streamflow, *Water resources management, *Water yield improvement, Bank stabilization, Channel stability, Colorado, Erosion control, Low flow, Oregon, Range management, Riparian vegetation, Runoff, Sediment control, Semiarid lands, Soil conservation, Utah, Vegetation, Water conservation, Water quality.

Baseflow augmentation refers to the temporary storage of subsurface water in floodplains, streambanks, and/or stream bottoms during the wet season, either by natural or artificial means, for later release during the dry season to increase the magnitude and permanence of low flows. Management strategies for baseflow augmentation fall into the following categories: (1) range management, (2) upland vegetation management, (3) riparian vegetation management, (4) upland runoff detention and retention, and (5) the use of instream structures. The benefits of a management strategy focused on baseflow augmentation are many, including: (1) increased summer flows, (2) healthier riparian areas, (3) increased channel and bank stability, (4) decreased erosion and sediment transport, (5) improved water quality, (6) enhanced fish and wildlife habitat, (7) lower stream temperatures, and (8) improved stream aesthetics. Case studies of baseflow augmentation are presented for Camp Creek, Oregon; Sheep Creek Barrier Dam, Utah; Alkali Creek, and Trout Creek, both in Colorado. Given its clear impact on soil and water conservation, particularly in the semiarid western U.S., it appears that baseflow augmentation is a concept worth investigating. Research is needed on how to integrate baseflow augmentation within comprehensive resource management strategies. (Author's abstract)
W90-09350

3C. Use Of Water Of Impaired Quality

NUTRIENT ACCUMULATION IN TREES AND SOIL FOLLOWING IRRIGATION WITH MUNICIPAL EFFLUENT IN AUSTRALIA.
Victoria Dept. of Conservation, Forests and Lands, State Forests and Lands Service, Melbourne (Australia).
H. T. L. Stewart, P. Hopmans, D. W. Flinn, and T. J. Hillman.
Environmental Pollution ENPOEK, Vol. 63, No. 2, p 155-177, 1990. 3 fig, 6 tab, 36 ref.

Descriptors: *Biomass, *Fertilization, *Fertilizers, *Irrigation, *Land disposal, *Limiting nutrients, *Municipal wastewater, *Plant growth, Australia, Bioaccumulation, Calcium, Eucalyptus trees, Magnesium, Nitrogen, Phosphorus, Sodium, Weed control.

Irrigation of tree crops is being evaluated as a method of land disposal of municipal effluent in Australia. A study was carried out from 1980-1984 in which seven tree species were sprinkler-irrigated with effluent at an annual rate of 1191-1752 mm. Effective weed control and frequent irrigation resulted in good survival of all species (83-100%) at 12 months. Total productivity was estimated at age 4 years by measuring biomass of each species inclusive of litter and roots to a soil depth of 80 cm. Biomass production of the high-yielding species Eucalyptus grandis and E. saligna, was around 10 kg/m squared. Percentage leaf mass of these species was small (8-9%) compared with 25% and 29% for the relatively slow-growing Casuarina cunninghamiana and Pinus radiata. Accumulation of nutrients in the total biomass differed significantly between species and ranged from 34-54 g/sq m for nitrogen, 4.0-10.4 g/sq m for phosphorus, 2.1-12.2 g/sq m for sodium, 22-34 g/sq m for potassium, 12-61 g/sq m for calcium and 4.7-9.3 g/sq m for magnesium. Chemical properties of soils (0-150 cm) were measured in 1980 and again in

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1984. Concentrations of total phosphorus, and exchangeable sodium, calcium, and magnesium were increased in the upper profile. Overall, soil chemical properties were not adversely affected by effluent irrigation over the four-year period, though there was a trend towards more sodic conditions in the soil profile. Nutrient accumulation in soil occurred mainly in the 0-35 cm depth, coinciding with the main root zone of the trees. Renovation of the effluent was therefore estimated as the amount of each nutrient accumulated in the biomass (averaged over the seven species) plus soil (0-35 cm), expressed as a percentage of amount applied in irrigation over the four years; that is, nitrogen, 29%; phosphorus, 78%; sodium, 15%; potassium, 26%; calcium, 98%,; and magnesium, 54%. (Author's abstract)
W90-08732

BERMUDAGRASS RESPONSE TO LEACHING FRACTIONS, IRRIGATION SALINITY, AND SOIL TYPES.
Nevada Univ., Reno. Dept. of Plant Science.
D. A. Devitt.
Agronomy Journal AGJOAT, Vol. 81, No. 6, p 893-901, November/December 1989. 5 fig, 3 tab, 21 ref.

Descriptors: *Bermudagrass, *Impaired water use, *Irrigation, *Leaching, *Saline water, *Turf grasses, *Wastewater irrigation, Canopy, Evapotranspiration, Model studies, Plant growth, Plant water potential, Saline soils, Sand, Soil types, Soil-water-plant relationships.

A study was conducted to determine the impact that varied leaching fractions, irrigation salinity, and soil types had on root growth and distribution, and fractional water uptake of bermudagrass (Cynodon dactylon). Bermudagrass was grown for a two-year period in large columns packed with three different soil types (sandy loam, silt loam, and clay). Saline water was synthesized and applied at three different salinity levels (electrical conductivities of 1.5, 3.0, and 6.0 dS/m). Irrigations were applied three days a week at a rate beyond measured evapotranspiration to establish three different leaching fractions (0.09, 0.18, and 0.27). The soil salinity, soil solution chloride, root density, and volumetric water contents were measured in soil cores taken with depth and time. Dry matter of weekly grass clippings was measured and recorded throughout the two-year period. Plant water status was monitored by measuring canopy temperatures and leaf xylem water potentials. Results indicated that bermudagrass was very tolerant to the range of salinity-leaching conditions imposed. However, differences were noted by treatments, with the sandy soil showing as much as a 25% yield decrement at the highest salinity level. Salinity of the irrigation water, rather than soil salinity was more highly correlated with most of the soil-plant-water relationships observed. Root length density was best described by a hyperbolic function. Only limited success was found in correlating root length density with fractional water uptake. In addition, poor correlations were found between soil salinity with depth and fractional water uptake. These findings indicate that the ability to predict water uptake based on root distribution and/or soil salinity would be poor and that great error might occur in using such an approach in predictive models. (Author's abstract)
W90-08930

USE OF SALINE DRAINAGE WATER FOR IRRIGATION: IMPERIAL VALLEY STUDY.
Agricultural Research Service, Riverside, CA. Salinity Lab.
For primary bibliographic entry see Field 3F.
W90-09006

INTERCEPTING, ISOLATING, AND REUSING DRAINAGE WATERS FOR IRRIGATION TO CONSERVE WATER AND PROTECT WATER QUALITY.
Agricultural Research Service, Riverside, CA. Salinity Lab.
For primary bibliographic entry see Field 3F.
W90-09007

SALT SENSITIVITY OF COWPEA AT VARIOUS GROWTH STAGES.
Agricultural Research Service, Riverside, CA. Salinity Lab.
For primary bibliographic entry see Field 2I.
W90-09022

3D. Conservation In Domestic and Municipal Use

VALUING URBAN WATER ACQUISITION.
Texas A and M Univ., College Station. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6B.
W90-09345

3F. Conservation In Agriculture

WATER ALLOCATION UNDER A RIPARIAN SYSTEM TAKING INTO ACCOUNT SURFACE AND GROUNDWATER INTERACTIONS--THE CASE OF IRRIGATION DEVELOPMENT IN THE HEADWATERS OF THE SUSQUEHANNA RIVER.
Cornell Univ., Ithaca, NY.
For primary bibliographic entry see Field 6E.
W90-08857

ADAPTIVE STEM AND ADVENTITIOUS ROOT RESPONSES OF TWO TOMATO GENOTYPES TO FLOODING.
Purdue Univ., Lafayette, IN. Dept. of Horticulture.
For primary bibliographic entry see Field 2I.
W90-08894

EVAPOTRANSPIRATION OF COOL-SEASON GRASSES GROWN WITH MINIMAL MAINTENANCE.
Oregon State Univ., Corvallis. Dept. of Horticulture.
For primary bibliographic entry see Field 2I.
W90-08895

SEQUENTIALLY ADDITIVE AND OTHER INTERACTIONS BETWEEN NITROGEN FERTILIZER AND IRRIGATION ON THE YIELD OF WHEAT GRAIN IN A FIELD IN KANSAS.
California Univ., Los Angeles. Lab. of Biomedical and Environmental Sciences.
A. Wallace.
Journal of Plant Nutrition JPNUDS, Vol. 13, No. 3/4, p 411-423, 1990. 9 fig, 3 tab, 3 ref.

Descriptors: *Crop production, *Irrigation, *Nitrogen, *Nutrients, *Soil-water-plant relationships, *Wheat, Crop yield, Fertilizers, Kansas, Leaching, Plant growth, Plant physiology, Statistical analysis.

Three cultivars of wheat (Triticum aestivum L.) were grown in a field experiment with three nitrogen levels (0, 84, 168 kg/ha) and three irrigation systems (dryland, limited irrigation, and full irrigation) to make nine treatments for each of three different cultivars. Sequentially additive, synergistic and antagonistic interactions were observed. The 84 kg/ha of nitrogen was more effective without irrigation than the same nitrogen with limited and full irrigation indicating either nitrogen leaching with irrigation or additional nitrogen stress resulting from increased growth due to the irrigation. With 84 kg/ha of nitrogen, actual responses to nitrogen and irrigation were less than those predicted by sequential additivity indicating that the irrigation was too much for the 84 kg rate of nitrogen. At times, both nitrogen and water were Liebig-type limiting factors and at other times they were Mitscherlich-type factors. The results of this study are an excellent example of the value of overcoming two different limiting factors simultaneously in the improvement of crop yields and of possible problems which could hinder the sequentially additive interaction. (Author's abstract)
W90-08904

YIELD AND QUALITY OF PROCESSING TOMATOES IN RESPONSE TO IRRIGATION RATE AND SCHEDULE.
North Carolina State Univ. at Raleigh. Dept. of Horticultural Science.
For primary bibliographic entry see Field 2I.
W90-08905

ANTITRANSPIRANT REDUCES WATER USE BY PEACH TREES FOLLOWING HARVEST.
Texas A and M Univ., College Station. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 2I.
W90-08908

MICROSPRINKLER IRRIGATION AND GROWTH OF YOUNG 'HAMLIN' ORANGE TREES.
Florida Univ., Gainesville. Dept. of Fruit Crops.
For primary bibliographic entry see Field 2I.
W90-08909

IRRIGATION SCHEDULING MODEL FOR SNAP BEAN.
Georgia Coastal Plain Experiment Station, Tifton.
D. A. Smittle, W. L. Dickens, and J. R. Stansell.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 115, No. 2, p 226-230, March 1990. 2 fig, 3 tab, 22 ref.

Descriptors: *Beans, *Irrigation practices, *Irrigation scheduling, *Mathematical models, *Plant water potential, Crop production, Fertilizers, Irrigation programs, Model studies, Nitrogen, Nutrients.

An irrigation scheduling model for snap bean (Phaseolus vulgaris L.) was developed and validated. The model was validated using a line source irrigation system with irrigation depths ranging from 3% to 145% of the model rate in 1985 and from 4% to 180% of the model rate in 1986. Nitrogen fertilization rates ranged from 50% to 150% of the recommended rate both years. Marketable pod yields increased as irrigation rate increased in 1985. Irrigation at 4%, 44%, 65%, 80%, 150%, and 180% of the model rate produced yields that were 4%, 39%, 71%, 85%, 92%, and 55% as great as yields with the model rate in 1986. Marketable pod yields increased as nitrogen rate increased when irrigation was applied at 80%, 100%, or 150% of the model rate in 1986, but pod yields varied less with nitrogen rate when irrigation was applied at 4%, 44%, 65%, or 180% of the model. (Author's abstract)
W90-08910

EFFECT OF ZERO AND CONVENTIONAL TILLAGE ON BARLEY YIELD AND NITRATE NITROGEN CONTENT, MOISTURE AND TEMPERATURE OF SOIL IN NORTH-CENTRAL ALBERTA.
Alberta Univ., Edmonton. Dept. of Soil Science.
For primary bibliographic entry see Field 2I.
W90-08914

KINEMATIC OVERLAND FLOW MODEL TO DETERMINE DEPRESSION STORAGE OF TILLED SURFACES.
Agricultural Univ., Wageningen (Netherlands). Dept. of Land and Water Use.
For primary bibliographic entry see Field 2E.
W90-08915

EFFECTS OF SURFACE MANAGEMENT ON THE HYDROLOGY OF A VERTISOL IN SEMI-ARID AUSTRALIA.
Queensland Dept. of Primary Industries, Bundaberg (Australia).
M. M. Sallaway, D. F. Yule, D. Mayer, and P. W. Burger.
Soil and Tillage Research SOTRD5, Vol. 15, No. 3, p 227-245, February 1990. 10 fig, 2 tab, 20 ref.

Descriptors: *Arid climates, *Australia, *Land use, *Overland flow, *Rainfall-runoff relationships,

*Soil erosion, *Tillage, Crop production, Cultivation, Flood peak, Rainfall, Rainfall intensity, Runoff volume, Soil water, Surface roughness, Vegetation.

Rapid expansion of cropping in semi-arid northeastern Australia in recent years has led to major changes in catchment hydrology and the potential for erosion. Runoff volume and peak runoff rates are influenced by storm rainfall and its intensity, tillage practices, surface cover, surface roughness and surface soil water deficit, but the influences are not well defined for general use. Data were obtained on contour catchments varying from 8-16 ha under different tillage and crop treatments, over a four-year period. The response of runoff and peak runoff rate to the interactive effects of the independent variables was examined using multiple regression analysis. As expected, the main factor affecting runoff volumes was total rainfall, while peak runoff rate was mainly determined by rainfall intensity. The other variables had smaller, interactive effects. The major effects of the management practices were soil water deficit on total runoff and surface cover on peak runoff rate. The process of runoff generation is complex. Surface cover, surface roughness and soil water deficit can be managed to minimize both total runoff and peak runoff rate. Maintenance of surface cover by reduced or zero-tillage practices is the most stable and dependable approach during fallow, and early establishment of a growing crop will further decrease both runoff and runoff rate. Benefits from increasing surface roughness by cultivation are greatly cancelled by the associated reduction in surface cover. (Author's abstract)
W90-08916

ENERGY BALANCE AND WATER USE OF CROPS.
Nebraska Univ.-Lincoln. Center for Agricultural Meteorology and Climatology.
J. Kim, S. B. Verma, and N. J. Rosenberg.
Agricultural and Forest Meteorology AFMEEB, Vol. 48, No. 1/2, p 135-147, October 1989. 11 fig, 1 tab, 28 ref. NSF Grants ATM-8205431 and ATM-8417995.

Descriptors: *Agricultural water, *Cereal crops, *Evapotranspiration, *Plant physiology, *Stomatal transpiration, *Water stress, *Water use efficiency, Air temperature, Barley, Bowen ratio, Crop production, Great Plains, Nebraska, Seasonal variation, Solar radiation, Vapor pressure, Water potentials, Wheat, Wind speed.

Micrometeorological measurements were made in spring barley (Hordeum vulgare L., Custer) and winter wheat (Triticum aestivum L., Colt) crops at Mead, Nebraska, an east central Great Plains location. Diurnal and seasonal patterns of the energy balance components were evaluated using the Bowen ratio technique. Such information is needed for an adequate understanding of the ways in which plant communities respond to the environmental stresses encountered in the semi-arid to sub-humid Great Plains. Based on this information, appropriate methods for optimizing crop production and water use efficiency can be developed. The energy partitioning was controlled by the atmospheric evaporative demand (i.e., vapor pressure deficit, air temperature, wind speed) and by availability of soil water. Frequently, advection of sensible heat influenced energy partitioning strongly by increasing evapotranspiration (ET). Percentage of net radiation consumed by ET decreased progressively from 90 to 50% in both crops as they senesced. Stomatal conductance of the barley crop, which experienced mild water stress, decreased with decreasing leaf water potential below a 'critical value' and with increasing vapor pressure deficit. Stomatal conductance in well-watered wheat responded to test radiation and appeared to be independent of leaf water potential and vapor pressure deficit. Water use efficiency ranged from 0 to 8.3 (g dry matter/kg water used) for barley and from 0 to 13.6 for wheat depending on the growth stage and the availability of soil water. (Brunone-PTT)
W90-08919

SHORT-TERM ESTIMATION OF SORGHUM EVAPOTRANSPIRATION FROM CANOPY TEMPERATURE.
Texas Agricultural Experiment Station, Temple. Blackland Research Center.
For primary bibliographic entry see Field 2D.
W90-08920

EVAPORATION FROM IRRIGATED WHEAT ESTIMATED USING RADIATIVE SURFACE TEMPERATURE: AN OPERATIONAL APPROACH.
Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Centre for Irrigation Research.
R. C. G. Smith, H. D. Barrs, and W. S. Meyer.
Agricultural and Forest Meteorology AFMEEB, Vol. 48, No. 3/4, p 331-344, November 1989. 9 fig, 3 tab, 18 ref.

Descriptors: *Energy transfer, *Evaporation, *Irrigation management, *Plant physiology, *Solar radiation, *Temperature, *Wheat, Aerodynamic resistance, Diurnal variation, Lysimeters, Mathematical models, Penman model, Plant growth, Priestly-Taylor model, Seasonal variation, Wind speed.

Hourly values of latent energy flux (LE) of wheat, calculated from the energy balance of the stand using infrared measurements of crop temperature to estimate sensible heat flux (H), were compared with measurements made by a weighing lysimeter. Measurements spanned a period of 50 days in which the phenology of the crop changed from anthesis to physiological maturity, soil water deficit increased from 0 to 150 mm over the last 20 days, and weather varied seasonally and diurnally. The energy balance estimate accounted for 76% of the variance in LE, but its accuracy was insensitive to the correction of aerodynamic resistance for atmospheric stability and wind speed effects. In comparison, the Penman and Priestly-Taylor models of evaporation accounted for only 58% and 41%, respectively, of the variance in LE. The superiority of the energy balance estimation was due to the significance of H in the energy balance under this wide range of conditions. LE was overestimated under unstable and underestimated under stable conditions. Over a day, however, unstable conditions predominated before solar noon and stable conditions after solar noon. Therefore, when making daily estimates of LE, this source of error tended to be self-cancelling. Hence, the energy balance estimate accounted for 86% of the variance for LE averaged over the day, compared with 76% when individual hourly averages were used. These results may be useful for improving the operational use of evaporation estimates for the management of irrigated crops. This approach has been used to develop an automatic irrigation system for a lawn in which the timing of the irrigation and the quantity of water to apply is determined on the basis of the energy balance estimate of evaporation. (Brunone-PTT)
W90-08924

COMPARISON OF BOWEN RATIO AND AERODYNAMIC ESTIMATES OF EVAPOTRANSPIRATION.
Laboratoire de Bioclimatologie, Peronne (France).
For primary bibliographic entry see Field 2D.
W90-08928

EVALUATING PLANT WATER STRESS WITH CANOPY TEMPERATURE DIFFERENCES.
National Oceanic and Atmospheric Administration, Idaho Falls, ID. Environmental Research Labs.
K. L. Clawson, R. D. Jackson, and P. J. Pinter.
Agronomy Journal AGJOAT, Vol. 81, No. 6, p 858-863, November/December 1989. 6 fig, 28 ref.

Descriptors: *Agriculture, *Data acquisition, *Evapotranspiration, *Irrigation requirements, *Mathematical models, *Plant water potential, *Water stress, Air temperature, Alfalfa, Canopy, Irrigation, Net radiation, Penman-Monteith model, Vapor pressure.

The temperature stress day (TSD) has been used as a remotely sensed indicator of plant water stress

without a thorough knowledge of TSD behavior. A study was conducted to demonstrate a dependence of the TSD on net radiation (R), air temperature (T) and atmospheric water vapor pressure (VPD), and to evaluate a replacement water status index. The dependence on these parameters was proven by the following methods: (1) theoretically, using the Penman-Monteith resistance equation; (2) empirically, using the non-water-stressed baseline equation relating canopy and air temperature to VPD; and (3) in a field experiment with alfalfa (Medicago sativa) on an Anthropic Torrifluvent soil. The effect of these parameters caused the field-measured TSD to vary up to 7 C, rendering its utility as a plant stress indicator questionable. A modification of the crop water stress index (CWSI), which accounts for R, T, and VPD, was proposed as the TSD replacement. The modification consisted of using a measured instead of estimated well-watered canopy temperature in the canopy temperature ratio defined by CWSI. This modified CWSI responded to imposed irrigation regimes as indicated through yield and evapotranspiration comparisons. The modified CWSI appears to be a suitable replacement for the TSD by accounting for environmental dependence while maintaining the measurement simplicity of the TSD. The greatest potential use of the modified CWSI may be in its application to aircraft--or satellite--acquired data. The coolest temperature of a given crop could be assumed to represent the well-water canopy temperature. This assumption would be particularly appropriate for irrigated areas where the index would be of greatest value for irrigation scheduling. (Brunone-PTT)
W90-08929

WATER MARKETING EFFECTS ON CROP-WATER MANAGEMENT.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
J. Letey, and A. Dinar.
California Agriculture CAGRA3, Vol. 43, No. 6, p 15-16, November/December 1989. 1 fig.

Descriptors: *Agricultural water, *California, *Irrigation efficiency, *Marketing, *Water conservation, *Water management, *Water transfer, Drainage water, Irrigation, Irrigation ditches, Municipal water, Water pollution prevention.

Increasing urban populations must be accommodated by increasing water supplies. However, opportunities in California to develop additional freshwater supplies for human use are limited and expensive. A partial transfer of water presently being used for agriculture to urban use has been considered to satisfy increasing urban water demands. Water marketing has been proposed as a means of facilitating the water exchange. The agreement between the Metropolitan Water District of Southern California and the Imperial Irrigation District is an example of a form of water marketing that will provide an additional 100,000 acre-feet of water per year for urban use (an amount that would provide domestic water for approximately 700,000 people). Metropolitan agreed to cement-line leaking irrigation ditches carrying water to fields and make other improvements in exchange for the water conserved. Water marketing leads to reduced nonpoint source pollution by greatly reducing the amount of deep percolation. Water marketing allows the farmer to pay substantial rates for drainage water disposal with modest loss of income. Reduction of drainage water volumes and the farmer's ability to pay disposal costs could enhance the environment for fish and wildlife in the western San Joaquin Valley. Legal, political and implementation barriers must be overcome before a water marketing system can be adopted. Nevertheless, the results of this study clearly identify the advantages to both urban and agricultural water users and environmental quality. They also indicate that strong efforts to develop a water marketing system directed toward on-farm irrigation management are advisable. (Brunone-PTT)
W90-08934

Group 3F—Conservation In Agriculture

TURFGRASS ALTERNATIVES WITH LOW WATER NEEDS.
California Univ., Riverside. Dept. of Botany and Plant Sciences.
V. A. Gibeault, J. L. Meyer, R. Autio, and R. Strohman.
California Agriculture CAGRA3, Vol. 43, No. 6, p 20-22, November/December 1989. 2 fig, 1 tab.

Descriptors: *Bermudagrass, *Irrigation, *Landscaping, *Turf grasses, *Water conservation, Evapotranspiration, Fertilization, Plant growth, Seasonal variation, Water requirements.

Many recreational facilities require a uniform, well-maintained turf sward. Turfgrass provides the smooth surface needed, as well as a safety 'cushion'. Turfgrass and other plants also improve urban environments, reducing glare and traffic noise. Turf also reduces or controls soil erosion. Turfgrass species require significant amounts of irrigation water to sustain their growth, appearance and usefulness. A study was conducted to evaluate the turf quality of low-water requiring turfgrasses and groundcovers when irrigated at low irrigation levels and maintained with regular mowing. The research plot was seeded in April, 1984. Following establishment, the site was irrigated at 100% of calculated evapotranspiration for warm-season grass, fertilized at 0.5 pound nitrogen per 1000 square feet per months with ammonium sulfate and mowed every week at 1.5 inches with a rotary mower. Differential irrigation, consisting of 20, 40 and 60% of calculated evapotranspiration began in March, 1985. Plant material characteristics for turf quality (a composite of color, texture, density, and uniformity) were rated visually at regular intervals, using a 1 to 9 rating system. Additionally, the percentage of live desired plant material was determined as percent cover. Of 27 species of turfgrass and groundcovers tested, bermudagrasses and seashore Paspalum were the best performing turfgrasses under very low irrigation regimes. Two species of saltbush, buffalograss and two varieties of Phalaris also gave comparatively good cover and quality. These species apparently resist the stress of low water application by various mechanisms, including dormancy, deep roots and low rates of water use. (Brunone-PTT)
W90-08935

IMPROVED LEWIS-MILNE EQUATION FOR THE ADVANCE PHASE OF BORDER IRRIGATION.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
V. P. Singh, P. D. Scarlatos, and S. N. Prasad.
Irrigation Science IRSCD2, Vol. 11, No. 1, p 1-6, 1990. 4 fig, 2 tab, 15 ref.

Descriptors: *Border irrigation, *Lewis-Milne equation, *Mathematical equations, Advance phase, Depth, Irrigation, Mathematical studies.

The Lewis-Milne (LM) equation has been applied widely for design of border irrigation systems. The LM equation is based on the concept of mass conservation, while the momentum balance is replaced by the assumption of a constant surface water depth. Although this constant water depth depends on the inflow rate, slope, and roughness of the infiltrating surface, no explicit relation has been derived for its estimation. Assuming negligible border slope, the present study theoretically treats the constant depth of the LM equation by using the simple dam-break wave solution along with boundary layer theory. The wave front is analyzed separately from the rest of the advancing water by considering both friction and filtration effects on the momentum balance. The resulting equations in their general form are too complicated for closed-form solutions. Solutions therefore are given for specialized cases, and the mean depth of flow is presented as a function of the initial water depth at the inlet. The solution was calibrated and tested using experimental data. Conclusions resulting from this study are: (1) the surface mean water depth in the LM equation is not constant and may vary with time; this variation tends to increase in time during the advance phase; (2) the computed and calibrated values of the mean depth during the advance phase of border irrigation are in good

agreement; (3) the mean depth increases with increasing inflow discharge, increasing surface friction, or decreasing infiltration; for quantification of these relations, application of more experimental or field data is required; and (4) numerical solution of the complete wave front advance equation should yield even better results. (Rochester-PTT)
W90-08949

ESTIMATION OF FIELD SCALE LEACHING RATES FROM CHLORIDE MASS BALANCE AND ELECTROMAGNETIC INDUCTION MEASUREMENTS.
New South Wales Dept. of Agriculture, Deniliquin (Australia).
For primary bibliographic entry see Field 2K.
W90-08950

EFFECTIVE IRRIGATION UNIFORMITY AS RELATED TO ROOT ZONE DEPTH.
Hebrew Univ. of Jerusalem (Israel). Seagram Centre for Soil and Water Sciences.
R. Wallach.
Irrigation Science IRSCD2, Vol. 11, No. 1, p 15-21, 1990. 4 fig, 18 ref.

Descriptors: *Irrigation, *Root zone, *Soil water, *Spatial distribution, Irrigation design, Mathematical equations, Mathematical studies, Uniformity.

In models used for relating the yield to irrigation uniformity it has been assumed that the spatial distribution of irrigation water, as measured at the soil surface, is indeed the water distribution at any depth throughout the root zone. Here the distribution of infiltrated water within the soil bulk, as determined by an analytic solution of the two-dimensional unsaturated flow equation, did not conform to that assumption. An alternative definition of irrigation uniformity is proposed under the assumption that water uptake by roots does not affect the flux distribution within the soil profile. In this analysis, the spatial distribution of irrigation water at the soil surface, which is the upper boundary condition of the flow equation, is assumed to be a sine function. The solution to this problem indicates that there is a 'damping' effect, which increases with soil depth, on the surface flux fluctuations. Furthermore, the actual irrigation uniformity at a given depth below the soil surface depends on the initial uniformity at the surface and the distance between adjacent water sources. The closer water sources are to each other, the shallower is the depth needed to damp the oscillations down to a certain level. This may explain why the actual uniformity of drip irrigation is high while the detailed distribution is very nonuniform and on the other hand why the actual uniformity of sprinkler guns is low while the detailed actual distribution are close to uniform. Two uniformity coefficients are derived: (1) a depth-dependent coefficient made up with a damping factor that multiplies the flux fluctuations at the soil surface and (2) an effective uniformity coefficient, which is an average of the depth-dependent coefficient over a part of the entire root zone. (Author's abstract)
W90-08951

VARIABILITY OF SOIL WATER TENSION IN A TRICKLE IRRIGATED CHILE PEPPER FIELD.
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
J. M. H. Hendrickx, and P. J. Wierenga.
Irrigation Science IRSCD2, Vol. 11, No. 1, p 23-30, 1990. 5 fig, 2 tab, 29 ref.

Descriptors: *Irrigation efficiency, *Moisture tension, *Soil water, *Spatial distribution, *Trickle irrigation, Data acquisition, Drip irrigation, Monitoring, Network design, Peppers, Tensiometers.

Soil-water tension variability in a 0.15-ha, drip-irrigated chile pepper field was evaluated to determine the number of tensiometers required for scheduling irrigations in such a field. Four plots were irrigated with a trickle irrigation system. Fifty tensiometers were installed in each plot and monitored 13 days using a handheld pressure transducer (tensiometer). The standard deviations of the

soil-water tensions were relatively high (30 cm at 50 cm tension) and increased when the soil became drier (180 cm at 400 cm tension). The variability of the log-transformed soil-water tension values did not increase as the soil became drier. Forty-eight out of 52 sets of soil-water tension measurements were approximately log-normally distributed. Therefore, it appears that the log-transformed soil-water tension values should be used for statistical inference about the mean soil water status in the field. Temporal stability of the soil-water tension readings persisted for one irrigation interval. Using a previously determined production function (yield vs soil-water tension), it was shown for this the field that about seven tensiometers were needed to determine the threshold tension value above which yield starts to decrease. (Author's abstract)
W90-08952

SIMULATED WATER AND SOLUTE DISTRIBUTION FROM A CROSSED TRIPLE LINE-SOURCE.
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
D. A. Magnusson, and J. B. Asher.
Irrigation Science IRSCD2, Vol. 11, No. 1, p 31-36, 1990. 4 fig, 3 tab, 6 ref.

Descriptors: *Irrigation, *Irrigation requirements, *Soil water, *Solute transport, Crossed triple line source, Mathematical models, Nitrogen, Salinity, Spatial distribution.

Multivariable irrigation experiments usually are expensive and seldom cover the whole range of desired values. The crossed triple line-source (CTLS) was designed to provide a relatively simple and inexpensive irrigation system for creating continuous gradients of more than one variable. A computer model was developed to assist in evaluating the continuously changing multivariable levels produced by the CTLS given various inputs. The distribution function of a single sprinkler was used in development of the model. The results of the overlapping sprinkling patterns were calculated throughout the experimental area (four 12 m by 12 m plots) for water depth, salinity level, and N concentration. Measured values of irrigation water electrical conductivity and N concentration agreed well with predicted values. The model provides a quick and accurate method for examining water and variable distribution for single irrigation or for an entire season produced by the CTLS. (Author's abstract)
W90-08953

ECONOMIC ANALYSIS OF IRRIGATION SYSTEMS.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
J. Letey, A. Dinar, C. Woodring, and J. D. Oster.
Irrigation Science IRSCD2, Vol. 11, No. 1, p 37-43, 1990. 3 fig, 2 tab, 20 ref.

Descriptors: *Cost-benefit analysis, *Economic aspects, *Irrigation, Drainage water, Gravity flow irrigation, Pressurized irrigation, Wastewater disposal.

Pressurized irrigation systems provide better control on the amount of applied water and, in most cases, better irrigation uniformity than gravity flow systems. They also have a higher initial capital cost than gravity flow systems and an analysis is required to determine whether the improved performance of pressurized systems justifies the additional costs. An economic analysis was done on several irrigation systems, including: consideration of farm management costs associated with a given irrigation system, shifts in crop yield and drainage volumes associated with the optimal management of each irrigation system and costs associated with disposal of drainage waters. Cotton was selected as the crop for analysis. Irrigation uniformity significantly affected the results. Although irrigation uniformities can be highly variable based on design, maintenance, and management, a typical uniformity for each irrigation system was selected. For the conditions of the analysis, gravity flow systems were calculated to be more profitable than

pressurized systems if there was no constraint on the amount of drainage water generated or the cost for its disposal. Imposition of costs for drainage water disposal induced a shift whereby pressurized systems become more profitable than gravity flow systems. (Author's abstract)
W90-08954

SAP FLOW IN THE STEM OF WATER STRESSED SOYBEAN AND MAIZE PLANTS.
Agricultural Research Organization, Bet-Dagan (Israel). Inst. of Soils and Water.
For primary bibliographic entry see Field 2I.
W90-08955

PLANT WATER RELATIONS AND NUTRIENT UPTAKE IN FRENCH BEAN.
Indian Inst. of Horticultural Research, Bangalore. Div. of Soil Science.
For primary bibliographic entry see Field 2I.
W90-08956

MUNGBEAN RESPONSE TO IRRIGATION WITH WATERS OF DIFFERENT SALINITIES.
Central Soil Salinity Research Inst., Karnal (India).
P. S. Minhas, D. R. Sharma, and B. K. Khosla.
Irrigation Science IRSCD2, Vol. 11, No. 1, p 57-62, 1990. 6 fig, 2 tab, 11 ref.

Descriptors: *Crop yield, *Irrigation practices, *Mungbean, *Salinity, Depth, Plant physiology, Soil water, Water blending.

Experiments were conducted in lysimeters (1985) and field plots (1986) to evaluate changes in soil moisture and salinity status following irrigations with different blends of saline water, SW (EC sub iw = 6.4 dS/m) and non-saline water, NSW (EC sub iw = 0.3 dS/m) and their effects on the growth and yield of mungbean (Vigna radiata L. Wilczek). Normalized to the yield of the treatment receiving NSW (100%), relative seed yields (RY) declined to 73, 11, and 3%, respectively, for the treatments receiving SW:NSW blends of 1:2 (2.5 dS/m), 2:1 (4.7 dS/m), and SW only. RY increased to 64% and 74% when NSW was substituted for presowing irrigation and 2:1 SW:NSW blend and SW, respectively, were used for postsowing irrigations. Due to moderating effect of rainfall (9.8 cm) during the growing season of 1986, values of RY obtained with 1:2 and 2:1 SW:NSW blends were 81 and 42% and increased to 96 and 82% when these waters were applied after presowing irrigation with NSW. Irrigation at presowing with non-saline water leached the salts of shallow depths, leading to better germination and initial growth. In addition plants were able to extract greater amounts of water even from deeper soil layers. The RY of mungbean was related to the weighted, time-averaged salinity of the 0-120 cm soil depth (EC sub e) by RY = 100-20.7(EC sub e -1.8). The study indicated that applying NSW for presowing irrigation to mungbean is more beneficial than using it after blending with saline water. (Author's abstract)
W90-08957

GROWTH, YIELD AND SOIL WATER EXTRACTION OF IRRIGATED AND DRYLAND PEANUTS IN SOUTH SULAWESI, INDONESIA.
Balai Penelitian Tanaman Pangan Maros, Ujung Pandang (Indonesia).
A. Prabowo, B. Prastowo, and G. C. Wright.
Irrigation Science IRSCD2, Vol. 11, No. 1, p 63-68, 1990. 2 fig, 2 tab, 13 ref.

Descriptors: *Crop yield, *Indonesia, *Irrigation, *Peanuts, *Soil water, Comparison studies, Dry farming, Plant physiology, Water deficit, Water stress.

Irrigation at 35 and 70 mm of pan evaporation applied during the pre-early and/or post-early pod-filling stages increased pod yield of Spanish peanuts (100 day maturity) three-fold compared to a dryland crop. There was no difference in pod yield in crops receiving 12 compared to 6 irrigations. Soil water sampling immediately after irrigations

on selected treatments revealed that infiltration of irrigation water probably was restricted to less than 20 cm, a response that resulted in poor soil water replenishment and low irrigation efficiency. Even though roots extracted soil water below the compaction layer (20 cm), severe crop water deficits had developed by the end of irrigation cycles during later, but not earlier, stages of growth. The dryland crop, which received no rainfall during the season, presumably extracted significant amounts of soil water at depths to and below 1.2 m. Despite producing about 2.9 t/ha of total dry matter yield, pod yield was extremely low (0.5 t/ha) arising from low pod numbers and high percentage of empty pods. (Author's abstract)
W90-08958

VARIANCE OF WATER ADVANCE IN WIDE-SPACED FURROW IRRIGATION.
Oklahoma State Univ., Stillwater. Dept. of Agronomy.
M. E. Hodges, J. F. Stone, J. E. Garton, and D. L. Weeks.
Agricultural Water Management AWMADF, Vol. 16, No. 1/2, p 5-13, August 1989. 1 fig, 3 tab, 6 ref.

Descriptors: *Furrow irrigation, *Irrigation design, *Wetting, Oklahoma, Optimization, Performance evaluation, Sorghum, Spatial distribution.

Characteristics of water flow in widely-spaced furrow irrigation (W) 2.84 m, were compared to every-furrow irrigation (E) 1.42 m, in a study conducted at Goodwell, Oklahoma, on a clay loam soil with grain sorghum. Water was applied at a constant 0.75 L/sec rate to all furrows. Because W prevents meeting of wetting fronts from adjacent furrows, it was expected that water would advance more slowly in the W than in E due to the continual lateral wetting in W. Rate of advance of water down the furrow in the E treatment ranged from 1.23 to 1.48 times greater than in W depending on soil type and slope. Logarithm of distance of advance of furrow stream varied closely with logarithm of time for each furrow, indicating that measurements made relatively early in the irrigation of a furrow could predict rate of advance while irrigating. Advance rates of the W treatment were no more variable than the E. W could be adjusted by trial and error to advance at the same rate as E by making needed adjustments to furrow inflow rate to W early in the irrigation. Several adjacent E furrows in the field close by would be needed for comparison to make this adjustment. (See also W90-09005) (Author's abstract)
W90-09004

YIELD VARIABILITY AND WATER USE IN WIDE-SPACED FURROW IRRIGATION.
Oklahoma State Univ., Stillwater. Dept. of Agronomy.
M. E. Hodges, J. F. Stone, and H. E. Reeves.
Agricultural Water Management AWMADF, Vol. 16, No. 1/2, p 15-23, August 1989. 1 fig, 3 tab, 11 ref.

Descriptors: *Crop yield, *Furrow irrigation, *Infiltration, *Irrigation design, Cracks, Oklahoma, Performance evaluation, Sorghum, Spatial distribution, Variability.

Characteristics of crop yield and water use in widely-spaced furrow irrigation (W) were compared to every-furrow irrigation (E) in a study conducted at Goodwell, Oklahoma, on a clay loam soil with grain sorghum (Sorghum bicolor (L.) Moench). E furrows were 1.42 m apart and W applied water to alternate furrows (2.84 m spacing). W treatments caused no greater yield variation down the furrow than the E treatment, although about half the water was applied to W plots as to E. In the W treatments not all the furrows were irrigated at once and, on occasion, the dry furrows were observed to crack. Subsequent irrigation to cracked dry furrows showed significantly greater penetration of water into the profile than the E treatments. Soil water tended to be depleted to a greater degree in the W treatments than in the E treatment over the growth season, but seasonal evapotranspiration was lesser in the W plots. (See also W90-09004) (Author's abstract)

W90-09005

USE OF SALINE DRAINAGE WATER FOR IRRIGATION: IMPERIAL VALLEY STUDY.
Agricultural Research Service, Riverside, CA. Salinity Lab.
J. D. Rhodes, F. T. Bingham, J. Letey, G. J. Hoffman, and A. R. Dedrick.
Agricultural Water Management AWMADF, Vol. 16, No. 1/2, p 25-36, August 1989. 1 fig, 6 tab, 34 ref.

Descriptors: *California, *Drainage water, *Imperial valley, *Irrigation design, *Saline water, *Wastewater irrigation, Literature review, Salt tolerance, Standards.

Evidence is presented to support the expansion of agriculture through the increased use of saline waters for irrigation. Two kinds of evidence are presented to support this view: (1) literature documenting the successful use of saline waters for irrigation throughout the world, even when conventional management is employed, and (2) results of a field test that demonstrates the feasibility of the use of saline irrigation water through the development of new crop/water management strategies and practices. Some studies have claimed that seawater (35,000 mg/L) could be used for irrigation, but they are not convincing. However, numerous studies have shown that successful cultivation is possible using water in the 1500-6000 mg/L range of total dissolved solids. Indirect evidence of the potential to use saline drainage waters for irrigation has been obtained from computer models designed to predict soil water composition resulting from irrigation and models developed to relate crop response to soil salinity. A new crop/water management strategy designed to permit the use of brackish irrigation water was tested for 4 yr under commercial farming conditions in a 20-ha field located in the Imperial Valley of California. The use of saline water for irrigation can be enhanced if a dual rotation (crop and water) is employed. In this management system, substitution of saline water for low-salinity irrigation water causes no significant yield reduction, loss of cropping flexibility, or change in current farming operations at certain times during the crop rotation. Salt-sensitive crops (lettuce, alfalfa, etc.) in the rotation are irrigated with low-salinity water whereas saline water is applied to the salt-tolerant crops (cotton, sugarbeets, wheat, etc.). Customary water quality standards for irrigation appear to have been based on the availability of good quality water and are too conservative. (See also W90-09007) (Rochester-PTT)
W90-09006

INTERCEPTING, ISOLATING, AND REUSING DRAINAGE WATERS FOR IRRIGATION TO CONSERVE WATER AND PROTECT WATER QUALITY.
Agricultural Research Service, Riverside, CA. Salinity Lab.
J. D. Rhoades.
Agricultural Water Management AWMADF, Vol. 16, No. 1/2, p 37-52, August 1989. 6 fig, 4 tab, 20 ref.

Descriptors: *Wastewater irrigation, *Water conservation, *Water quality control, *Water reuse, California, Drainage water, Irrigation design, Management planning, Theory, Water blending.

Theoretical and conceptual evidence is given, along with four case examples, to show that a loss of usable water occurs in the total water supply when agricultural drainage waters are returned to the water supply, even when blending is carried out such that apparently safe limits of salt concentration are not exceeded in the final mixture. An alternative means of managing agricultural drainage waters is offered that provides a greater practical benefit from the total water supply than does blending. Even though the concentration of a blend may appear to be low enough to be acceptable by conventional standards, the usability of the good-quality water supply for growing salt-sensitive crops (or for other salt-sensitive water uses) is

reduced through the process of blending. Each time the salt content of an agricultural water supply in increased, the degree to which it can be consumed before its concentration becomes excessive is reduced. More crop production usually can be achieved from the total water supply by just solely using the good-quality water component. Serious consideration should be given to keeping saline drainage waters separate from the good-quality water supplies, even when the saline waters are to be reused for irrigation. They can be used more effectively by substituting them for the conventional water in the irrigation of certain crops grown in the rotation after seedling establishment. The feasibility of such reuse for irrigation has been demonstrated in field studies in California. Reuse of drainage water for irrigation of suitably salt-tolerant crops reduces the volume of drainage water needing ultimate disposal and the off-site pollution problems associated with the discharge of irrigation return flows. (See also W90-09006) (Rochester-PTT)
W90-09007

EFFECT OF GYPSUM AND SODIC IRRIGATION WATER ON SOIL AND CROP YIELDS IN A RICE-WHEAT ROTATION.
Punjab Agricultural Univ., Ludhiana (India). Dept. of Soils.
M. S. Bajwa, and A. S. Josan.
Agricultural Water Management AWMADF, Vol. 16, No. 1/2, p 53-61, August 1989. 3 fig, 3 tab, 13 ref.

Descriptors: *Crop yield, *Irrigation design, *Rice, *Salinity, *Wheat, Exchangeable sodium percentage, Gypsum, Hydrogen ion concentration, Plant physiology, Sodic water.

A field experiment was conducted for 6 yr on a Typic Ustoschrept to examine the influence of different amounts of gypsum, applied either at each irrigation or in one dose, on the amelioration of deteriorating effects of sodic water irrigations under a fixed rice-wheat cropping cycle. Two sodic waters (SW1 and SW2) having, respectively, electrical conductivities of 0.85 and 0.95 dS/m, sodium adsorption ratios (SAR) of 8.4 and 13.5, and residual sodium carbonated of 6.8 and 10.3 meq/L, were prepared by dissolving NaHCO3 in a good quality canal water. Continuous sodic irrigations increased pH, SAR, and exchangeable sodium percentage (ESP) in the soil and significantly decreased yields of crops as compared with the canal-water. Harmful effects were higher under SW2. Application of gypsum decreased pH, SAR, and ESP of the top 0-60 cm soil and hence increased yields of crops. Increase in levels of gypsum progressively decreased the Na saturation of the soil. ESP values observed under gypsum, whether applied at each irrigation or in one dose were almost similar. There was no effect of different rates and methods of gypsum application on wheat yield. In rice, small amounts of gypsum applied in one dose were less beneficial. Gypsum, to supply 2.5 and 5 meq Ca/L of sodic irrigation water for wheat and rice, respectively, was sufficient to maintain high yields. (Author's abstract)
W90-09008

LONG-TERM MOISTURE CONTROL FOR SOILS WITH SHALLOW GROUNDWATER TABLE.
Agricultural Univ. of Warsaw (Poland). Dept. of Land Reclamation.
For primary bibliographic entry see Field 2G.
W90-09010

MODELLING THE EFFECTS OF TIED-RIDGING ON WATER CONSERVATION AND CROP YIELDS.
Texas Agricultural Experiment Station, Temple. Blackland Research Center.
J. H. Krishna.
Agricultural Water Management AWMADF, Vol. 16, No. 1/2, p 87-95, August 1989. 4 tab, 18 ref.

Descriptors: *Furrow irrigation, *Irrigation effects, *Tied-ridging, *Water conservation, CORDIKE, COTDIKE, Cotton, Crop yield, Dikes,

Irrigation design, Maize, Mathematical models, Plant growth, Runoff, SORDIKE, Simulation, Sorghum.

Tied-ridging, also known as furrow-diking, is a practical, efficient, and low-cost technique to conserve water in micro-impoundments between crop rows and provide valuable additional moisture for crop production. Mathematical models combining hydrologic and crop growth processes were developed to simulate runoff and to estimate the effect of conserving the runoff by diking on crop yields. The models called SORDIKE, CORDIKE, COTDIKE were run with 25-yr weather data from five Texas locations to evaluate the long-term effects of diking on sorghum, maize, and cotton yields, respectively. These models can predict the likely impact of furrow-diking on dryland and irrigated crop yields at any location where agro-climatic and soil data are available. (Author's abstract)
W90-09011

SYSTEMS APPROACH TO DRAINAGE REDUCTION IN THE SAN JOAQUIN VALLEY.
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 5G.
W90-09012

EFFECT OF SOIL MATRIC POTENTIAL AND NITROGEN ON GROWTH, YIELD, NUTRIENT UPTAKE AND WATER USE OF BANANA.
Indian Inst. of Horticultural Research, Bangalore. Div. of Soil Science.
D. M. Hegde, and K. Srinivas.
Agricultural Water Management AWMADF, Vol. 16, No. 1/2, p 109-117, August 1989. 6 tab, 20 ref.

Descriptors: *Banana, *Crop yield, *Irrigation design, *Soil water potential, *Water use, Biomass, India, Nitrogen, Plant growth, Plant physiology, Potassium.

The influence of irrigating at different soil matric potentials (-25, -45, -65, and -85 kPa at 15 cm depth) under different levels of nitrogen (100, 200, and 300 g/plant) on growth, yield, nutrient uptake and water use of banana ('Robusta') were investigated at the Indian Institute of Horticultural Research, Bangalore. The most frequent irrigation, at a soil matric potential of -25 kPa, resulted in maxima of growth, dry matter, and yield, but data were not significantly different from those for irrigation at -45 kPa. Infrequent irrigations at -65 and -85 kPa delayed flowering and had a significantly adverse effect on growth and yield. Nutrient uptake (except K) declined with decreasing frequency of irrigation and mostly followed the changes in dry matter. Banana irrigated at -45 kPa use 1601 mm of water in 485 days. Increasing N fertilization improved growth, yield, nutrient uptake, and water use, although no difference between application rates of 200 and 300 g/plant was found. (Author's abstract)
W90-09013

MICROCOMPUTER FOR ON-LINE CONTROL AND OPERATION OF CLOSED-CONDUIT IRRIGATION SYSTEMS: AN ECONOMICAL ASSESSMENT.
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
G. Oron.
Agricultural Water Management AWMADF, Vol. 16, No. 1/2, p 137-154, August 1989. 2 fig, 4 tab, 7 ref.

Descriptors: *Computers, *Control systems, *Irrigation design, *Irrigation operation, *Microcomputers, *Telemetry, Cost analysis, Data processing, Economic aspects, Israel, Performance evaluation.

The use of microcomputers in closed-conduit irrigation systems was analyzed economically. The microcomputer-controlled system consists of two major components: (1) the computing center, which includes the computer, the display system, and the printer, as well as a DC power source and/ or the transformer for the AC system and (2) the field equipment, which consists of moveable and/

or permanent point units. Expected benefits are in the areas of water and fertilizer saving, energy and labor saving, and database management. Costs associated with the microcomputer system are the microcomputer and related equipment, training, and operation and maintenance expenses. The suggested framework was applied in two cases from Israel: (1) Hatzerim settlement, with a total cultivated area under irrigation of approx 200 ha, and (2) Telaleem settlement, with about 185 ha under cultivation. By the use of microcomputers, annual expenses can be reduced in the range of US$20-100 per hectare based on the results from these two cases. (Rochester-PTT)
W90-09015

IRRIGATION WATER PRICING POLICIES TO REDUCE AND FINANCE SUBSURFACE DRAINAGE DISPOSAL.
Hebrew Univ. of Jerusalem, Rehovoth (Israel). Faculty of Agriculture.
A. Dinar, K. C. Knapp, and J. Letey.
Agricultural Water Management AWMADF, Vol. 16, No. 1/2, p 155-171, August 1989. 2 fig, 5 tab, 10 ref.

Descriptors: *Drainage water, *Irrigation programs, *Pricing, *Wastewater disposal, *Water pollution control, Economic aspects, Evapotranspiration, Investment, Irrigation design, Optimization, Regulations, Seasonal variation.

Disposal of water collected in agricultural subsurface drainage systems normally has been done without direct charge to the farmer. In some case, drainage water disposal costs are becoming very high, so that the institution of incentives for the farmer to reduce drainage volumes and pay for their safe disposal are appropriate. The consequences of various irrigation water pricing policies on optimal irrigation application, profits, and drainage volumes were analyzed for cotton grown under three levels of irrigation uniformity. The unregulated case led to applied water and drainage flows that exceeded the economically efficient levels. A direct charge on drainage waters equal to their disposal costs induced economically efficient water application but required a drainage water volume monitoring system. A flat fee on irrigation water could be set to induce an economically efficient water application. However, in this cases the revenues generated by the imposition of the extra charge greatly exceeded the costs of disposal. Selection of the flat fee to equalize revenues and treatment costs resulted in excessive irrigation compared to the economically efficient levels. Tiered water pricing, whereby the unit water price is increased as volume increases, is another option. When the seasonal crop evapotranspiration was selected as the level to impose the tiered pricing, the tiered price could be selected to induce economically efficient applications. However, the revenues generated by the tiered price were less than the costs of disposal. Water pricing policies suffered from being sensitive to irrigation uniformity. Investment in irrigation technology to improve irrigation uniformity is justified, and the level of investment increases as the costs for drainage water disposal increase. (Author's abstract)
W90-09016

NUMERICAL KINEMATIC WAVE MODEL FOR BORDER IRRIGATION.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
S. K. Jain, and V. P. Singh.
Irrigation Science IRSCD2, Vol. 10, No. 4, p 253-263, 1989. 1 fig, 3 tab, 18 ref.

Descriptors: *Border irrigation, *Infiltration, *Irrigation design, *Kinematic wave theory, *Model studies, Mathematical equations, Mathematical models, Numerical analysis.

A numerical model is developed to solve kinematic wave equations of border irrigation. This model accommodates transient infiltration, which may be defined by any of the well-known infiltration models. Test runs performed using different incremental values of time and space, gave results

within 5% of one another, thus showing the stability of the numerical model. The conservation of volume of water was satisfied within 1% error at different values of time and space. Three sample data sets from field experiments were used to analyze the numerical model. The scheme presented here is stable and does not suffer from convergence problems. The scheme is simple to program and use, and provides the user the flexibility of choosing his/her own infiltration model. Infiltration models are used as separate modules. The scheme was adequate to model the entire irrigation cycle for the data analyzed and can be applied to any other data. (Rochester-PTT)
W90-09017

GROWTH AND NITROGEN ECONOMY OF RICE UNDER SPRINKLER AND FLOOD IRRIGATION IN SOUTH EAST AUSTRALIA: III. 15N BALANCE.
Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Centre for Irrigation Research.
E. Humphreys, F. M. Melhuish, W. A. Muirhead, R. J. G. White, and J. Blackwell.
Irrigation Science IRSCD2, Vol. 10, No. 4, p 281-292, 1989. 1 fig, 4 tab, 38 ref.

Descriptors: *Crop yield, *Irrigation, *Nitrogen cycle, *Rice, *Tracers, Australia, Flood irrigation, Nitrogen radioisotopes, Nutrients, Plant physiology, Sprinkler irrigation, Ureas.

15N balances were compared in rice (Oryza sativa L. cv. Calrose) grown under continuous flood (CF) or sprinkler irrigation. Two sprinkler treatments with irrigation frequencies of once (S1W) or three times (S3W) per week were studied. Five atom percent 15N-labelled urea (60 kg N/ha) was applied to microplots either 36 or 84 days after emergence (DAE). An equivalent amount of unlabelled urea was applied at the other application time, so that each microplot received a total of 120 kg N/ha in an equal split. There was no significant effect of irrigation treatment on recovery of urea N by straw. Straw recovery from urea applied 36 DAE was almost half that from an application of 84 DAE and time of urea application produced a similar effect on recovery in grain. Grain recovery in S1W was less than half that in CF and S3W for both application times. Total plant recovery of urea N applied 36 DAE was similar for all irrigation treatments (average 29%), but for urea applied 84 DAE total plant recovery in CF (67%) was significantly higher than in S1W (49%). Total N uptake in the plant tops was considerably lower in both the sprinkler-irrigated treatments when compared with CF, and this was mostly due to reduced soil N uptake in S3W (one-half) and S1W (one-third). The proportion of N derived from fertilizer in the plant tops increased from 40% in CF to 60% in S1W. Immobilization of applied N in the soil of sprinkler-irrigated treatments was greater than in CF. Immobilization of urea N applied 36 DAE was almost 50% greater than immobilization of urea applied 84 DAE. There was a trend for lower losses of fertilizer N with sprinkler irrigation (mean loss of 18% of applied N) compared with CF (27%). Within all irrigation treatments, the loss of urea applied 36 DAE was more than double the loss from urea applied 84 DAE. Split applications resulted in significantly increased plant recovery of applied 15N, largely associated with increased recovery in the grain. (Author's abstract)
W90-09019

IRRIGATION STUDIES ON WATERMELON (CITRILLUS LANATUS (THUNB) MATSUM ET NAKAI).
Indian Inst. of Horticultural Research, Bangalore. Div. of Soil Science.
K. Srinivas, D. M. Hegde, and G. V. Havanagi.
Irrigation Science IRSCD2, Vol. 10, No. 4, p 293-301, 1989. 8 tab, 11 ref.

Descriptors: *Crop yield, *Fruit crops, *Irrigation, *Nutrients, Biomass, Calcium, Comparison studies, Drip irrigation, Furrow irrigation, India, Magnesium, Nitrogen, Phosphorus, Potassium, Sugars, Water use efficiency.

Field experiments with watermelon carried out at Bangalore, India, during 1984 and 1985 indicated that frequent irrigations with 100% evaporation replenishment result in the highest fruit yield, dry matter production, total soluble solids, sugars, NO3-N, N, P, K, Ca, Mg uptake, and higher water use efficiency. However, yield differences were statistically significant only in 1985. Drip irrigation with 1 emitter/2 plants produced the highest yield and water use efficiency (WUE) compared to other irrigation treatments (drip 1 emitter/plant, furrow 25-mm depth, and furrow 50-mm depth). Dry matter, total soluble solids, sugars, N03-N, N, P, K, Ca, Mg uptake, and WUE under drip irrigation were higher than under furrow irrigation treatments. (Author's abstract)
W90-09020

INFLUENCE OF WATER STRESS ON KIWI-FRUIT GROWTH.
Ruakura Agricultural Research Center, Hamilton (New Zealand).
M. J. Judd, K. J. McAneney, and K. S. Wilson.
Irrigation Science IRSCD2, Vol. 10, No. 4, p 303-311, 1989. 6 fig, 13 ref.

Descriptors: *Crop yield, *Fruit crops, *Irrigation, *Water stress, Mathematical models, Plant growth, Plant physiology, Turgidity.

An irrigation experiment was conducted on young kiwifruit vines over two seasons to examine effects of water stress on fruit development. Vines were grown outdoors in a sandy rooting medium enclosed within a polyethylene-lined trench with removable surface covers to enable strict control of the water supply. Measurements of fruit growth, leaf water potential, and stomatal conductance were made throughout the season in conjunction with periods of water stress imposed at different times and for varying durations. Fruit development was very responsive to water stress, with mean fruit size per vine at harvest varying from 60 to 130 cu cm as a result of various stress treatments. Fruit expansion ceased when predawn leaf water potentials fell below -0.1 MPa. Upon rewatering, leaf turgor was regained within 24 hr even after severe, prolonged stress. Any turgor loss associated with fruit softening was made up quickly; thereafter, fruit growth continued at the same rate concurrently exhibited on continuously well-watered vines. These results suggest that stomatal conductance did not follow the rapid recovery of leaf water potentials and that fruit expansion may be more closely linked to water supply than to concurrent rate of photosynthesis. Despite the large range in mean fruit size, the shape of the fruit size distribution at harvest was not affected by water stress and it is concluded that harvest yields can be adequately modeled by assuming a normal distribution with a fixed standard deviation. (Author's abstract)
W90-09021

CALCULATING COLLECTIVE IRRIGATION NETWORKS WITH DEMAND LIMITATIONS (CALCUL DES RESEAUX COLLECTIFS D'IRRIGATION AVEC LIMITATION DE LA DEMANDE).
For primary bibliographic entry see Field 6D.
W90-09059

IMPACT OF CLIMATE VARIABILITY AND CHANGE ON WATER RESOURCES MANAGEMENT IN AGRICULTURE.
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Geographisches Inst.
For primary bibliographic entry see Field 2B.
W90-09110

ASSESSMENT OF CLIMATIC CHANGES IMPACTS ON WATER RESOURCES MANAGEMENT IN AN IRRIGATED ZONE.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2B.
W90-09111

STABILIZATION ROLE OF GROUNDWATER WHEN SURFACE WATER SUPPLIES ARE UNCERTAIN: THE IMPLICATIONS FOR GROUNDWATER DEVELOPMENT.
Minnesota Univ., St. Paul. Dept. of Agricultural and Applied Economics.
Y. Tsur.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 811-818, May 1990. 1 fig, 4 tab, 23 ref, append.

Descriptors: *Conjunctive use, *Groundwater, *Irrigation, *Irrigation management, *Surface water, *Water resources development, *Water supply, Agriculture, Aquifers, Arid-zone hydrology, Connate water, Deserts, Groundwater potential, Israel, Negev, Reservoirs, Water use.

The stabilization role of pumped groundwater, used conjunctively with surface water for irrigation, was studied. The economic benefit of this stabilization was first evaluated. Implications for the development of groundwater resources were then derived. In general, the investment in groundwater increased with the variability in the supply of surface water. Application of the analysis to the fossil water aquifer underlying the Negev desert in Israel showed that, with its rainfall variability (mean 293.118 mm; standard deviation, 110.957 mm for 38 years), the magnitude of the stabilization value of pumped groundwater could exceed the groundwater benefit attributed to the increase in water supply. In the example, the irrigated area (52,008 ha with a 100-year irrigation water demand of 4.4 billion cu m) was small relative to the size of the aquifer (30 to 70 billion cu m). Two wheat price levels were considered: $0.193/kg and $0.12/kg. Four levels of groundwater price were used: 0.05, 0.1, 0.15, and 0.2 $/cu m. It was beneficial to develop the aquifer in certain cases. The stabilization value of the groundwater was increased when allowed to improve the timing of water application within the growing season. Crop insurance schemes were expected to mitigate the stabilization role of the groundwater. (Cassar-PTT)
W90-09155

EFFECTS OF AMELIORATING EXPOSED SUBSOIL PRIOR TO SOWING ON THE WATER RELATIONS AND PRODUCTIVITY OF PASTURE DURING AN IRRIGATION CYCLE.
Kyabram Research Inst. (Australia). Dept. of Agriculture and Rural Affairs.
S. J. Blaikie, K. B. Kelly, and W. K. Mason.
Australian Journal of Agricultural Research AJAEA9, Vol. 40, No. 1, p 97-106, 1989. 6 fig, 3 tab, 21 ref.

Descriptors: *Irrigation efficiency, *Land forming, *Pasture management, *Pastures, *Soil treatment, *Soil-water-plant relationships, *Subsoil, Canopy, Crop yield, Evapotranspiration, Land use, Leaves, Photosynthesis, Soil water.

Adding organic matter or replacing topsoil have been shown to improve the growth of pasture on areas where subsoil is exposed during landforming. Intensive experiments were carried out in each of the 1985-86 and 1986-87 irrigation seasons to examine the basis of improvements in the productivity of pastures after such amelioration. Measurements were collected during the period between two irrigations which were separated by approximately 70 mm of cumulative Class A pan evaporation. Treatments included: (1) high rates of nitrogen and phosphorus (NP); (2) NP plus organic matter (OM); (3) NP plus topsoil (TS); and (4) NP plus well water (WW). Compared to NP, pasture production in OM and TS treatments was improved in the first year, but in the second year only the TS treatment gave significant improvement. These increases in dry matter yields were reflected in rates of leaf elongation, canopy conductance, evapotranspiration and photosynthesis that were up to 50% greater than those in WW during the first half of irrigation cycle, but there were no differences in leaf water potential. There was a strong relationship between canopy conductance and photosynthesis, and it appears that the plants in the TS and OM treatments were responding to an improved

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root perception of soil water availability. It is hypothesized that this allowed them to maintain canopy conductance and therefore photosynthesis at higher levels than in NP and WW. The improved performance of the TS and OM treatments represents an increase in the productive potential of exposed subsoil areas that cannot be achieved by improving fertilizer and irrigation management alone. (Author's abstract)
W90-09203

IMPACT OF AGRICULTURAL PRACTICES ON GROUNDWATER SALINITY.
Agricultural Research Service, Riverside, CA. Salinity Lab.
For primary bibliographic entry see Field 4C.
W90-09258

MOLECULAR CLONING OF A PLANT BETA-INE-ALDEHYDE DEHYDROGENASE, AN ENZYME IMPLICATED IN ADAPTATION TO SALINITY AND DROUGHT.
MSU/DOE Plant Research Lab., East Lansing, MI.
For primary bibliographic entry see Field 2I.
W90-09283

ANALYTICAL CLOSED BORDER IRRIGATION MODEL: I. THEORY.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
V. P. Singh, and F. X. Yu.
Agricultural Water Management AWMADF, Vol. 15, No. 3, p 223-241, May 1989. 8 fig, 1 tab, 32 ref.

Descriptors: *Border irrigation, *Irrigation design, *Mathematical models, *Model studies, *Soil water, Hydraulic roughness, Infiltration, Theoretical analysis, Volumetric analysis.

Knowledge of movement and distribution of water over and below the soil surface is required for a proper design of closed-border irrigation. Most mathematical models do not deal with the whole cycle of closed-border irrigation. Those models which do are numerical and too expensive to be used for large-scale design purposes. In order for a model to provide accurate results it must allow for inaccuracy of many variables including infiltration, roughness, geometric characteristics, initial conditions, and boundary conditions. Using a volume balance approach, an analytical model for the entire closed border irrigation cycle is derived. The irrigation cycle is simulated in five phases: advance, storage, vertical recession, horizontal recession, and impounding recession. (See also W90-09364) (Marks-PTT)
W90-09363

ANALYTICAL CLOSED BORDER IRRIGATION MODEL: II. EXPERIMENTAL VERIFICATION.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
V. P. Singh, and F. X. Yu.
Agricultural Water Management AWMADF, Vol. 15, No. 3, p 243-252, May 1989. 5 fig, 9 tab, 8 ref.

Descriptors: *Border irrigation, *Irrigation design, *Mathematical models, *Model studies, *Model testing, Error analysis, Groundwater recession, Soil water, Volumetric analysis.

Knowledge of movement and distribution of water over and below the soil surface is required for a proper design of closed-border irrigation. A mathematical model for the entire closed-border irrigation cycle using a volume balance approach was used to simulate the irrigation cycle in five phases: advance, storage, vertical recession, horizontal recession, and impounding recession. Using experimental data this model was evaluated with the emphasis placed on its usage in designing irrigation systems. Calculated and observed values of advance distances, vertical recession times, impounding distances, and horizontal recession times were compared. The average relative error was less than 8% in predicted advance, below 2% in predicted vertical recession, under 5% in predicted horizon-

tal recession, and within 6% for impounding distance. The model is simple, reasonably accurate, and easy to apply for modeling the entire closed-border irrigation cycle. (See also W90-09363) (Marks-PTT)
W90-09364

DISTILLATION IRRIGATION: A LOW-ENERGY PROCESS FOR COUPLING WATER PURIFICATION AND DRIP IRRIGATION.
Geological Survey, Menlo Park, CA. Water Resources Div.
J. Constantz.
Agricultural Water Management AWMADF, Vol. 15, No. 3, p 253-264, May 1989. 4 fig, 5 tab, 16 ref.

Descriptors: *Agriculture, *Desalination, *Drip irrigation, *Solar distillation, Brine disposal, Crop production, Impaired water use, Plastics, Temperature.

A method is proposed for combining solar distillation and drip irrigation to simultaneously desalinize water and apply this water to row crops. In this paper, the basic method is illustrated by a simple device constructed primarily of sheets of plastic, which uses solar energy to distill impaired water and apply the distillate to a widely spaced row crop. To predict the performance of the proposed device, an empirical equation for distillate production, DP, is developed from reported solar still production rates, and a modified Jensen-Haise equation is used to calculated the potential evapotranspiration, ET, for a row crop. Monthly values for ET and DP are calculated by using a generalized row crop at five location in the western United States. Calculated ET values range from 1 to 22 cm per month and calculated DP values range from 2 to 11 cm per month, depending on the location, the month, and the crop average. When the sum of DP plus precipitation, DP+P, is compared to ET for the case of 50% distillation irrigation system coverage, the results indicate that the crop's ET is matched by DP+P, at cooler locations only. However, when the system coverage is increased to 66%, the crop's ET is matched by DP+P even at the hottest location. Potential advantages of distillation irrigation include the ability: (a) to convert impaired water resources to water containing no salts or sediments; and (b) to efficiently and automatically irrigate crops at a rate that is controlled primarily by radiation intensities. The anticipated disadvantages of distillation irrigation include: (a) the high costs of a system, due to the large amounts of sheeting required, the short lifetime of the sheeting, and the physically cumbersome nature of a system; (b) the need for a widely spaced crop to reduce shading of the system by the crop; and (c) the production of a concentrated brine or precipitate, requiring proper off-site disposal. (Author's abstract)
W90-09365

MOVEMENT OF ATRAZINE BY WATER FROM APPLICATION SITES IN CONVENTIONAL AND NO-TILLAGE CORN PRODUCTION.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Plant Pathology, Physiology and Weed Science.
For primary bibliographic entry see Field 5B.
W90-09466

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

EMERGENCY PLAN FOR RED LAKE DAM AND RESERVOIR.
Army Engineer District, St. Louis, MO.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A206 199. Price codes: A04 in paper copy, A01 in microfiche. Final Report, May 1987. 50p, 3 tab, 2 plates, 3

append.

Descriptors: *Emergency planning, *Flood control, *Flood plain management, *Red Lake Dam, *Reservoir operation, Dam stability, Flood discharge, Flood routing, Maximum probable floods, Minnesota, Safety, Spillways.

The Plan implements the program to prepare emergency plans for all U.S. Corps of Engineers dams. It provides a guide for actions to identify and mitigate or respond to various types of emergencies which, while rare, could occur in the operation of Red Lake Dam, Minnesota, is located on the Red Lake River at the outlet of Lower Red Lake, approximately 18 miles northwest of the village of Red Lake, Minnesota and 196 river miles above the mouth of the Red Lake River. Red Lake Reservoir has an area of about 451 sq mi at the normal elevation (1174.0 ft). Potentially affected project areas would include all lands under the control of the Corps of Engineers and potentially affected by emergencies at Red Lake Dam and Reservoir. Red Lake Dam and Bridge, the roadway dike and all dams downstream on the Red Lake River could be affected by the increased flows they would have to handle. The potential causes of an emergency affecting the operation or safety of Red Lake Dam and Reservoir which were selected for planning include: excessive seepage; sabotage; extreme storm; slope failure; and foundation failure. Routing of the probable maximum flood results in a peak pool elevation of 1179.6 ft on Red Lake Reservoir. At this elevation, there is 1.9 ft of freeboard available. The existing spillway at Red Lake Dam was designed for a discharge of 3700 cu ft/sect and a maximum lake elevation of 1176.43 ft. The design capacity of the downstream channel is 1000 cu ft/sec. In periods of high runoff, Red Lake Reservoir is operated to reduce flooding in downstream areas. The occurrence of a maximum probable storm or a dam breach could cause uncontrolled release of water from the dam. Dam breach during a probable maximum flood event would most likely produce a minor increase in the peak outflow. The increased flow velocities and/or waves caused by the sudden release of a large volume of water under conditions of low flow and low tailwater would present a hazard to life and property in the vicinity of the dam at the time of failure. Flood damage in the Red Lake River Basin is mostly agricultural. Facilities that could sustain damage due to flooding include bridges, culverts and roadways. There are few residences or urban areas that would be affected by an emergency at Red Lake Dam. The project area affected encompasses parts or all of the following jurisdictions in Beltrami, Clearwater and Pennington Counties, Minnesota: (1) Red Lake Indian Reservation; (2) High Landing, Minnesota; (3) Thief River Falls, Minnesota; (4) Red Lake Falls, Minnesota; and (5) Crookston, Minnesota. (Lantz-PTT)
W90-08767

EMERGENCY PLAN FOR LEECH LAKE DAM AND RESERVOIR.
Army Engineer District, St. Louis, MO.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A206 197. Price codes: A07 in paper copy, A01 in microfiche. Final Report, March 1987. 117p, 3 tab, 3 plates, 4 append.

Descriptors: *Emergency planning, *Flood control, *Flood plain management, *Leech Lake Dam, Dam stability, Flood discharge, Flood routing, Hydrographs, Minnesota, Probable maximum flood, Safety, Spillways.

The Plan implements the U.S. Corps of Engineers program to prepare emergency plans for all Corps dams. It provides a guide for actions to identify and mitigate or respond to various types of emergencies which, while rare, could occur in the operation of Leech Lake Dam, Minnesota, which is located on the Leech Lake River at the outlet of Leech Lake. The dam is 27 river miles above the confluence of the Leech Lake and Mississippi Rivers and 1244.3 river miles above the mouth of the Ohio River. Emergencies at Leech Lake Dam

and Reservoir could endanger the safety of people and property within the borders of the project. The principal areas of concern are the reservoir surface and the Leech Lake Recreation Center. Emergencies at Leech Lake Dam and Reservoir could also create hazardous conditions on non-project lands including those in the vicinity of the reservoir. The potential causes of an emergency affecting the operation or safety of Leech Lake Dam and Reservoir which were selected for planning include: excessive seepage; sabotage; extreme storm; slope failure; and foundation failure. Outflow hydrographs were computed for the hypothetical cases of probable maximum flood without failure, probable maximum flood with failure, and failure at normal high pool elevation, which encompass the types of situations potentially resulting from dam failure. Hazardous conditions are defined as: (1) floodwater depths in excess of 2 feet, (2) flood water velocities which exceed 4 ft/sec, (3) floodwater depths of sufficient elevation to damage property. The boundaries of the areas expected to be inundated by the hypothesized conditions of probable maximum flood without failure and probable maximum flood with failure are shown in appendices. Unless otherwise noted, affected areas outside the inundation boundary are potentially subject to isolation, in most cases by flooding of roads serving the area. (Lantz-PTT) W90-08768

EMERGENCY PLAN FOR LOCK AND DAM NO. 6 TREMPEALEAU, WISCONSIN.
Army Engineer District, St. Louis, MO.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A206 200. Price codes: A04 in paper copy, A01 in microfiche. Final Report, July 1986. 56p, 3 tab, 2 plates, 3 append.

Descriptors: *Dams, *Emergency planning, *Flood control, *Flood plain management, *Locks, Dam stability, Flood discharge, Flood routing, Minnesota, Spillways, Trempealeau, Wisconsin.

The Plan implements the U.S. Corps of Engineers program to prepare emergency plans for all Corps dams. It provides a guide for actions to identify and mitigate or respond to various types of emergencies which, while rare, could occur in the operation of Lock and Dam No. 6 Trempealeau, Wisconsin, which is located on the Mississippi River 714.4 river miles above the mouth of the Ohio River, 14.1 river miles downstream from Lock and Dam 5A, and 11.9 river miles upstream above Lock and Dam 7. The main lock and the upper gate bay of an auxiliary lock are on the left bank of the river adjacent to the village of Trempealeau, Wisconsin. Lock and Dam No. 6 creates Pool 6, having an area of about 8,870 acres at project pool elevation 651.0 ft. The drainage area of the pool is 60,030 sq mi. Potentially affected project areas would include all lands under the control of the Corps of Engineers and potentially affected by emergencies at Lock and Dam No. 6. This would include the public use areas and would temporarily affect all the locks and dams downstream. The potential causes of an emergency affecting the operation or safety of Lock and Dam No. 6 include: excess seepage; sabotage; extreme storm; failure of earth dikes; and failure due to scouring. The standard project flood (SPF) at Lock and Dam 6 is 365,000 cu ft/sec. The existing spillway at Lock and Dam 6 was designed for a discharge of 180,500 cu ft/sec and a maximum pool elevation of 651.8 ft. The computed maximum discharge through the existing gated structure at SPF pool and tailwater conditions is 264,000 cu ft/sec. The peak discharge for the SPF is 365,000 cu ft/sec, which leaves a spillway inadequacy of 101,000 cu ft/sec and the potential for overtopping the dike by 3.1 ft. The failure of Lock and Dam No. 6's earthen dike has negligible effect on the SPF peak outflow due to the dam's low head differential and negligible influence in restricting high flows. Consequently, flooding downstream is not aggravated by failure of the dam during the Standard Project Flood. Also Lock and Dam No. 7 would temporarily become more difficult to control. The project area affected encompasses parts of or all of the following jurisdictions in Winona County located in Minnesota and Trempealeau County located in Wisconsin: (1) Trempealeau, Wisconsin; (2) Dakota, Minnesota; (3) Dresbach, Minnesota; (4) Midway, Wisconsin; (5) La Crosse, Wisconsin; and (6) Onalaska, Wisconsin. (Lantz-PTT) W90-08769

EMERGENCY PLAN FOR SANDY LAKE DAM AND RESERVOIR.
Army Engineer District, St. Louis, MO.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A206 198. Price codes: A08 in paper copy, A01 in microfiche. Final Report, June 1987. 42p, 4 tab, 11 plates, 4 append.

Descriptors: *Emergency planning, *Flood control, *Flood plain management, *Sandy Lake, *Sandy Lake Dam, Flood discharge, Flood routing, Hydrographs, Maximum probable floods, Minnesota, Spillways.

The Plan implements the U.S. Corps of Engineers program to prepare emergency plans for all Corps dams. It provides a guide for actions to identify and mitigate or respond to various types of emergencies which, while rare, could occur in the operation of Sandy Lake Dam and Reservoir Minnesota, which is one of six Mississippi headwaters reservoirs located in north central Minnesota. Sandy Lake Dam and Reservoir are located in Aitkin County near the village of Libby, Minnesota. The total area of the Sandy Lake watershed is 421 sq mi. Elevations range from 1575 ft in the extreme eastern portion of the watershed to 1217 ft at the Sandy Lake shoreline. Emergencies at the Sandy Lake Dam and Reservoir could endanger the safety of people and property within the borders of the project. The principal areas of concern are the reservoir surface and the Sandy Lake Recreation Area. Emergencies at Sandy Lake Dam and Reservoir could create a hazard to life and property on non-project lands including those in the vicinity of the reservoir, and along the Mississippi River below Libby, Minnesota. The potential causes of an emergency affecting the operation or safety of Sandy Lake Dam and Reservoir which were selected for planning include: excess seepage; sabotage; extreme storm; slope failure; and foundation failure. Outflow hydrographs were computed for the hypothetical cases of probable maximum flood (PMF) without and with failure and failure at normal high pool elevation. Outflow hydrographs were computed for the threshold flood, 40% PMF and 70% PMF with and without failure conditions. The threshold flood is the flood which fully uses the capacity of the reservoir and allows adequate freeboard at the dam. The threshold flood is equivalent to 10% of the PMF. Hazardous conditions exist when: (1) floodwater depths are in excess of 2 ft; (2) floodwater velocities exceed 4 ft/sec; and (3) floodwater depths are of sufficient elevation to damage property. An inundation map package is included as an appendix. Unless otherwise noted, affected areas outside the inundation boundary are potentially subject to isolation, in most cases by flooding of roads serving the area. (Lantz-PTT) W90-08770

OVERVIEW OF IMPORTANT ISSUES IN OPERATIONAL FLOOD CONTROL.
Politechnika Warszawska (Poland). Inst. of Automatic Control.
K. Malinowski.
IN: Computer Applications in Water Supply. Volume 2: Systems Optimization and Control. John Wiley and Sons, Inc., New York, New York. 1988. p 110-145. 6 fig, 54 ref.

Descriptors: *Computer models, *Flood control, *Flood forecasting, *Reservoir operation, Computer analysis, Computers, Floods, Forecasting, Model studies, Optimization, Simulation, Stochastic models.

Determining efficient operation of reservoirs during flood periods has always been an important problem in most multi-reservoir systems. Improved real-time flood control can increase protection of important municipal, industrial or agricultural developments against inundations. Modelling of flow transformation during flood periods in river channels is well advanced and effective algorithms for computer-based simulation are available. Several problems exist, however. Fast simulation methods are needed and model identification and validation need to be clarified. The key issue in flood control is operational forecasting of future events. Decision mechanisms for flood control in multi-reservoir systems will involve the use of optimization techniques. Design of decision rules, taking into account the uncertainty inherent in flood control, can be based on various optimization-based approaches such as the stochastic optimal control problem. Fully automatic flood control, based entirely upon the prescriptive models, is not very likely to be allowed in most situations. Development of effective real-time decision support systems that could be used under strain during flood emergency periods will require intelligent organization and management of both data and models, convenient and fast man-machine interfaces, and tools for interactive decision making. Although the theory of hierarchical control is well advanced, the specific features of operational management of floods must be taken into account when developing control structures. (See also W90-08799) (Mertz-PTT) W90-08806

SUBOPTIMAL APPROACH TO SCHEDULING OF RESERVOIR LEVELS FOR A MULTI-RESERVOIR WATER DISTRIBUTION NETWORK.
Politechnika Warszawska (Poland). Inst. of Automatic Control.
For primary bibliographic entry see Field 5F. W90-08811

CRITERIA FOR EVALUATING INSTREAM FLOW PROGRAMS: DECIDING WHAT WORKS.
National Ecology Research Center, Fort Collins, Co.
For primary bibliographic entry see Field 6B. W90-08853

SURFACE AND GROUND WATER ASSESSMENTS SUPPORTING INSTREAM FLOW PROTECTION AT THE HASSAYAMPA RIVER PRESERVE, WICKENBURG, ARIZONA.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2J. W90-08854

HYDROLOGIC ANALYSIS OF THE GULKANA NATIONAL WILD RIVER, ALASKA.
Bureau of Land Management, Lakewood, CO. Minerals and Environmental Protection Staff.
For primary bibliographic entry see Field 2E. W90-08856

DEVELOPMENT OF A SEDIMENT METHODOLOGY IN ALASKA.
Bureau of Land Management, Anchorage, AK. Alaska State Office.
For primary bibliographic entry see Field 2J. W90-08864

WATER SEEPAGE FROM UNLINED DITCHES AND RESERVOIRS.
Cornell Univ., Ithaca, NY.
N. W. T. Quinn, R. B. Smith, C. M. Burt, T. S. Slavin, and S. W. Styles.
California Agriculture CAGRA3, Vol. 43, No. 6, p 9-12, November/December 1989. 1 fig, 2 tab.

Descriptors: *California, *Ditch linings, *Drainage ditches, *Groundwater level, *Irrigation ditches, *Irrigation effects, *San Joaquin Valley, *Seepage loss, *Water table rise, Agricultural hydrology, Kostiakov equations, Regression analysis, Salinity, Soil moisture, Soil profiles.

Irrigation of agricultural land on the west side of the San Joaquin Valley since the mid-1960s has led to rising groundwater tables and an increased need

Group 4A—Control Of Water On The Surface

for on-farm drainage to sustain productivity. Preliminary field studies of ditch seepage losses performed in 1987 by Westlands Water District indicated that seepage losses from unlined ditches and reservoirs in the district could be as great as 50,000 to 70,000 acre-feet a year. Fifty-six test sites were selected, eighteen of which were tested twice during the growing season, and nineteen reservoirs. Soil samples were collected from the top one foot in the bottom of each test ditch. Soil texture was determined by the standard particle size analysis. Exchangeable sodium percentage, and salinity were also determined. The texture of the soil profile was determined through ribboning (manual evaluation) at one-foot intervals from the surface to a depth of six feet adjacent to each ditch test site. If a shallow groundwater table was present in the top six feet of the soil profile, the depth was recorded. Ditch dimensions were recorded for each site. Reservoir seepage was tested by first filling the reservoir and then installing staff gauges or by using an automatic surface level recorder. A regression model and Kostiakov equations were used to fit two models to the intake data. Data trend relationships were established for depth of flow, number of tractor passes, soil moisture depletion, exchangeable sodium percentage, height of water above field, and bottom width of ditch. Seepage losses from on-farm conveyances were 2.2 times higher than those from head ditches. Conveyance ditches accounted for about 43% of the total seepage loss from all facilities. Seepage from head and tailwater ditches accounted for about 31% of the total losses. Unfortunately, no single factor explained the differences in seepage rates between sites. The difficulty in modeling ditch and reservoir seepage losses means that such losses will need to be independently assessed in each water district affected by drainage problems. (Brunone-PTT)
W90-08933

DEVELOPMENT OF OPERATING RULES FOR THE VUOKSI RIVER BASIN.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 6A.
W90-09027

MODEL OF COMBINED WATER USE AND WATER DERIVATION PLANNING.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 6A.
W90-09029

IDENTIFYING THE CLIMATE-SENSITIVE SEGMENT OF BRITISH RESERVOIR YIELD.
Institute of Hydrology, Wallingford (England). Engineering Hydrology Div.
For primary bibliographic entry see Field 2A.
W90-09101

CHANGES OF WATER RESOURCES (ABOUT WATER MANAGEMENT OF HUNGARY).
Ministry of Environment and Water Management, Budapest (Hungary).
For primary bibliographic entry see Field 2A.
W90-09103

SIMULATING COSTS OF FLOODING UNDER ALTERNATIVE POLICIES FOR THE SACRAMENTO-SAN JOAQUIN RIVER DELTA.
California Univ., Davis. Dept. of Agricultural Economics.
S. H. Logan.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 799-809, May 1990. 2 fig, 5 tab, 17 ref. California Water Resources Project W-681.

Descriptors: *California, *Cost analysis, *Flood control, *Floods, *Rivers, Computer models, Deltas, Flood damage, Islands, Levees, Mathematical models, Model studies, Sacramento River, San Joaquin River, Water level.

A computer model was used to simulate floods and associated annual and present value costs for Cali-

fornia's Sacramento-San Joaquin Delta. Empirical probability distributions of stability failure and overtopping floods for 46 islands and tracts, conditioned on water levels, were used to simulate floods. Damage and reclamation costs were determined for island flooding. The cost of levee maintenance in nonflood years was a random variable. Multiple simulations over 5-year periods provided means and variances of annual costs of policies of reclaiming all flooded islands or reclaiming only some of them. When discounted, the resulting present value of a future stream of these costs may be compared to costs of alternative flood prevention programs (i.e., new levees). Results show that the present value of costs over 50 years for reclaiming all islands differed little from the comparable cost of reclaiming only 13 islands and leaving other islands flooded. Under both policies the present value of costs was less than the first cost of levee projects presented by the Corps of Engineers in the early 1980s. (Author's abstract)
W90-09154

STATE-SPACE MODEL FOR HYDROLOGIC RIVER ROUTING.
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-09157

EVALUATING DAM SAFETY RETROFITS WITH UNCERTAIN BENEFITS: THE CASE OF MOHAWK DAM (WALHONDING RIVER, OHIO).
Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Engineering and Public Policy.
For primary bibliographic entry see Field 8A.
W90-09179

MANAGEMENT OF THE SAI RIVER AND THE TATSUMI CANAL, JAPAN.
Kanazawa Inst. of Tech. (Japan). Dept. of Mechanical System Engineering.
For primary bibliographic entry see Field 6G.
W90-09255

POND SIZING FOR RATIONAL FORMULA HYDROGRAPHS.
Pennsylvania State Univ., University Park. Environmental Resources Research Inst.
G. Aron, and D. F. Kibler.
Water Resources Bulletin WARBAQ, Vol. 26, No. 2, p 255-258, April 1990. 4 fig, 1 tab, 5 ref.

Descriptors: *Detention reservoirs, *Graphical methods, *Hydrographs, *Rainfall-runoff relationships, *Rational formula, *Storage requirements, *Storm water, *Urban hydrology, Data interpretation, Rainfall rate.

The Modified Rational formula hydrograph and the Yarnell generalized rainfall chart are generally accepted procedures for sizing storm water detention ponds for small drainage areas. A procedure has been developed to choose the rainfall duration which, for a chosen return period, will result in the largest required storage volume of a detention pond. A graphical solution is provided and its use described by application to an example in which the detection volume to be investigated is for the 5-yr and 25-yr return periods, the 60-minute rainfall intensities are 1.5 and 2.0 in/hr, and the allowed detention pond outflow rates are 35 and 50 cu ft/sec, respectively. The results were very close to those obtained for the same problem by the traditional modified Rational method procedure based on incremental storm durations thus confirming the graphical-analytic solution. (Peters-PTT)
W90-09349

COMPUTER-AIDED PLANNING FOR MULTIPLE-PURPOSE RESERVOIR OPERATING POLICIES.
Colorado Univ. at Denver. Dept. of Civil Engineering.
L. E. Johnson.
Water Resources Bulletin WARBAQ, Vol. 26, No.

2, p 299-311, April 1990. 8 fig, 2 tab, 15 ref.

Descriptors: *Computer-aided planning, *Computers, *Multipurpose reservoirs, *Planning, *Public participation, *Reservoir operation, Colorado, Model studies, Public policy.

Computer-aided planning (CAP) for multiple-purpose reservoir operations involves use of state-of-the-art simulation and optimization methods, color graphic displays, and interactive computing interfaces. These technologies were integrated into a coherent system that has user-friendly interfaces to help the process of communicating reservoir system operations, solicit planning participant preferences and valuation judgments, and provide understandable feedback of system performance. The CAP system was imbedded in a comprehensive public involvement program that paralleled the reservoir operating policy modeling process, as part of multipurpose reservoir operations planning on the Great Plains Reservoirs in Colorado. Experience with the approach indicates the involved publics can quickly learn of reservoir system limitations and opportunities, and can indeed participate in the operations planning process. (Author's abstract)
W90-09354

SURFACE AND SUBSURFACE DRAINAGE SIMULATIONS FOR A CLAYPAN SOIL.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
S. Mostaghimi, P. C. McMahon, and W. D. Lembke.
Agricultural Water Management AWMADF, Vol. 15, No. 3, p 211-222, May 1989. 4 fig, 2 tab, 17 ref.

Descriptors: *Clays, *Drainage engineering, *Simulation analysis, *Subsurface drainage, *Surface drainage, Agriculture, Claypan soils, Computer models, Corn, Crop production, Drain spacing, Drainage systems, Impervious soils, Subsoil drainage, Water management.

A water management simulation model, DRAIN-MOD, was used to investigate the suitability of drainage systems for maize production on the claypan soils that occur widely in the midwest of the USA. These soils have a very slowly permeable shallow subsoil which severely limits root development and reduces crop yield. Climatological, crop, and soil data collected on claypan soil over several years were used in this study. Various subsurface drain spacings and combinations of surface and subsurface drainage systems on a claypan soil were simulated. Results indicated that supplemental irrigation, a subsurface drain spacing of 12 m under good surface drainage, and one of 10 m under poor surface drainage, are required. (Author's abstract)
W90-09362

4B. Groundwater Management

EQUITABLE GROUNDWATER MANAGEMENT IN THE TUCSON ACTIVE MANAGEMENT AREA.
Arizona Univ., Tucson. Dept. of Agricultural Economics.
K. A. Rait, and A. L. Lieuwen.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 249-257, 1 fig, 1 tab, 13 ref.

Descriptors: *Competing use, *Cost allocation, *Groundwater management, *Headwaters hydrology, *Water demand, *Water conservation, Agricultural water, Arizona, Costs, Groundwater withdrawal, Industrial water, Municipal water.

Groundwater management programs implemented by the Arizona Department of Water Resources (ADWR) attempt to reduce groundwater withdrawals through mandatory conservation measures. Groundwater users in municipal, agricultural, and industrial sectors must comply with increasingly stringent water use efficiencies. A comparative analysis of ADWR's groundwater conservation programs in the Tucson Active Management

Area (TAMA) reveals substantial inequities to the agricultural sector. An amended withdrawal fees provision is offered which could alleviate these inequities in the 1980 Groundwater Management Act. By distributing the costs of agricultural water conservation in a manner more consistent with the way in which local augmentation fees are assessed, the TAMA could achieve mandated water conservation goals in a more equitable manner. (See also W90-08822) (Author's abstract)
W90-08848

WATER SEEPAGE FROM UNLINED DITCHES AND RESERVOIRS.
Cornell Univ., Ithaca, NY.
For primary bibliographic entry see Field 4A.
W90-08933

CAUSES OF SOIL SALINIZATION: I. A BASIN IN SOUTHERN ALBERTA, CANADA.
Alberta Agriculture, Lethbridge.
For primary bibliographic entry see Field 2K.
W90-09139

STABILIZATION ROLE OF GROUNDWATER WHEN SURFACE WATER SUPPLIES ARE UNCERTAIN: THE IMPLICATIONS FOR GROUNDWATER DEVELOPMENT.
Minnesota Univ., St. Paul. Dept. of Agricultural and Applied Economics.
For primary bibliographic entry see Field 3F.
W90-09155

SURFACE AND SUBSURFACE DRAINAGE SIMULATIONS FOR A CLAYPAN SOIL.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 4A.
W90-09362

PROCEEDINGS OF THE FOCUS CONFERENCE ON EASTERN REGIONAL GROUND WATER ISSUES.
For primary bibliographic entry see Field 2F.
W90-09479

ALTERNATIVE TO LONG-TERM SHUTDOWN OF A MUNICIPAL WELL IN A SAND-AND-GRAVEL AQUIFER CONTAMINATED BY CYANIDE WASTES, SOUTHERN NEW HAMPSHIRE.
Whitman and Howard, Inc., Wellesley, MA.
D. R. DeNatale.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 257-271, 7 fig, 2 tab.

Descriptors: *Cyanide, *Groundwater management, *Groundwater pollution, *Municipal water, *Path of pollutants, *Water quality control, *Water supply, Aquifers, Drinking water, Groundwater movement, New Hampshire, Pumping wells.

In 1984, total cyanide (TCN) levels of 50 mg/L were found in groundwater on the fringe of a sand-and-gravel aquifer 1200 feet from a municipal well. The well was shut down in 1987 when cyanide-contaminated groundwater was found 375 feet from the well. In 1988, a study was conducted to assess whether the well could be used while lengthy aquifer clean-up and legal issues were resolved. Accordingly, a five-week, stepped-pumping test was conducted to determine the well's safe yield (safe from contamination). Pumpage was held at 80 gallons per minute (gpm) for the first two weeks, then increased to 140 gpm for two weeks, and raised to 300 gpm (design capacity) for the final week. Water from the municipal well and monitoring wells was regularly tested for cyanide. Water level elevations, recorded frequently at 19 measuring points, were integrated to make ground-water flow nets. The study showed that contaminated groundwater (up to 1 mg/L TCN in monitoring wells) bypasses the municipal well under non-pumping conditions. Flow nets indicated that

pumping the municipal well at 80 gpm resulted in no apparent diversion of contaminated water toward the well. At 140 gpm, the edge of the cyanide plume was apparently diverted toward the well. Pumping at 300 gpm produced a near-total deflection of the plume toward the well. Cyanide was undetected in the municipal well during the test. The municipal well was returned to service in early 1989, pumping continuously at 150 gpm. This rate is considered safe, in view of the drinking water standard for cyanide (0.154 mg/L), cyanide levels in the plume, and dilution from 'clean' groundwater and a nearby brook. (See also W90-09479) (Author's abstract)
W90-09498

DETERMINING THE AREA OF CONTRIBUTION TO A WELL FIELD: A CASE STUDY AND METHODOLOGY FOR WELLHEAD PROTECTION.
BCI Geonetics, Inc., Laconia, NH.
W. J. Griswold, and J. J. Donohue.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 345-357, 5 fig, 1 ref.

Descriptors: *Case studies, *Groundwater budget, *Groundwater mining, *Groundwater resources, *Hydrologic budget, *Water pollution control, *Water pollution prevention, *Wells, Aquifers, Groundwater movement, Groundwater recharge, Potentiometric level, Pumping.

A geohydrological evaluation for wellhead protection is conducted in this case study of an alluvial valley-fill aquifer in central Massachusetts. The criteria for wellhead protection in Massachusetts are set by the Department of Environmental Quality Engineering (DEQE) and are among the most technically detailed and sophisticated in the nation. DEQE defines its wellhead protection areas as the zone of contribution to a well or wellfield under the most severe pumping conditions that could be reasonably expected, i.e., 180 days of continuous pumping with no areal recharge. This report presents a practical, technically defensible, step-by-step method which groundwater professionals can employ to produce a project to address the spirit and letter of the law aimed at wellhead protection. The evaluation begins with the development of an initial conceptual model of the area, evaluating such key elements as surficial and bedrock geology, associated contributions to groundwater flow, recharge potential and induced infiltration from streams. The conceptual model is tested and revised through the installation of monitoring wells. Detailed measurements of ambient conditions both of groundwater and surface water flows are taken to isolate the effects of the well(s) from the natural variations in the overall flow regime. The aquifer is then subjected to the stress of a required 120-hour pumping test. The results of analysis of the pumping test and ambient conditions are used in a numerical model to extrapolate from the 120-hour test to the 180-day, no-recharge conditions dictated by DEQE regulations. Finally, the modeled 180-day drawdown results are subtracted from a potentiometric surface map reflecting average non-pumping conditions. The area of contribution is delineated from a flownet constructed on the resultant potentiometric surface. (See also W90-09479) (Author's abstract)
W90-09504

PAST, PRESENT AND FUTURE OF GROUNDWATER DEVELOPMENT IN THE TRI-CITIES OF KITCHENER, WATERLOO AND CAMBRIDGE ONTARIO, CANADA.
Water and Earth Science Associates Ltd., Carp (Ontario).
R. M. Woeller, and R. N. Farvolden.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 387-406, 2 fig.

Descriptors: *Groundwater management, *Groundwater mining, *Water management,

*Water resources development, Cambridge, Kitchener, Long-term planning, Ontario, Water conveyance, Water supply, Waterloo.

Kitchener, Waterloo and Cambridge, Ontario, have obtained their water supplies from groundwater sources for a hundred years. The current supply system is comprised of 35 overburden wells which are grouped in nine well fields, 20 bedrock wells in three well fields and an induced infiltration field of 5 horizontal collectors and 3 vertical wells near the Grand River. The peak demand for water during the summer of 1988 in the tri-cities was about 218,180 cu m/d (48 million imperial gallons per day (MIGD)). The system is currently only capable of supplying 204,550 cu m/d (45 MIGD). The projected peak water supply requirements for the year 2006 are 290,910 cu m/d (64 MIGD). A number of technically feasible long term and short term water supply alternatives are available to alleviate the short fall. These are the installation of additional 7 day peak flow augmentation facilities within existing well fields (7.7 MIGD) and construction of additional river infiltration galleries (4.0 MIGD). Long-term solutions include: the development of the groundwater resource potential outside the tri-city municipal boundaries (13.8 MIGD); development of an artificial recharge site at Mannheim (54 MIGD); installation of a direct surface source from the Grand River (16 MIGD); and, construction of a pipeline to one of the Great Lakes. The selection of an alternative has been the focus of ongoing debate between business, government, and the professional groundwater community. Work is currently proceeding on implementing the artificial recharge site option. Current shortfalls will be covered by improving peak water supply capability through peak flow augmentation within existing well fields. (See also W90-09479) (Author's abstract)
W90-09507

4C. Effects On Water Of Man's Non-Water Activities

EVALUATION OF HEMATOTOXIC EFFECTS OF TWO COMMONLY USED FERTILIZERS, DIAMMONIUM PHOSPHATE AND UREA, ON FISH CLARIAS BATRACHUS.
Lucknow Univ. (India). Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W90-08666

EFFECT OF DRAINAGE ON NUTRIENT RELEASE FROM FEN PEAT AND ITS IMPLICATIONS FOR WATER QUALITY: A LABORATORY SIMULATION.
Sheffield Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 5B.
W90-08691

TRANSLOCATION OF AN ESTUARINE WHELK AND ITS TREMATODE PARASITES IN AUSTRALIA.
Scripps Institution of Oceanography, La Jolla, CA.
C. A. Appleton.
Environmental Conservation EVCNA4, Vol. 16, No. 2, p 172-173, 182, Summer 1990. 3 fig, 18 ref.

Descriptors: *Animal parasites, *Australia, *Epidemiology, *Estuarine environment, *Human diseases, *Introduced species, *Mollusks, *Translocation, *Trematodes, Dermatitis, Swan River Estuary.

Interest in invasive and translocated organisms has received considerable impetus during the past decade, but relatively few cases are on record of invasive mollusks having become involved as intermediate hosts in the transmission of trematodes into their adopted habitats. Schistosome dermatitis, caused by the penetration of human skin by the cercariae of the avian blood-fluke Austrobilharzia terrigalensis has become an annual problem for users of the Swan River estuary, Perth, Western Australia. Questionnaires were sent to residents who had contracted dermatitis after contact with

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the water, to provide the basis for an epidemiological study. A number of residents noted that it was only since the early 1960s that they experienced dermatitis after swimming in the estuary. The intermediate host of the avian blood fluke is the mud whelk Velacumantus australis, which is primarily located in Port Philip Bay, Victoria, roughly 3500 km away. The first record of the mud whelk in the Swan River was in 1954, and it did not appear regularly in collections until the early 1960s, the time that dermatitis was first noticed. There is little doubt but that V. australis was inadvertently introduced into the Swan River estuary through human agency around 1950, and has become established there. In addition to being the intermediate host of A. terrigalensis, the mud whelk also serves as intermediate host for Strictodora lari and Philopthalmus burrilli. These three trematode species are now transmitted in the estuary, probably being translocated by infected migratory coastal birds. Of the three flukes involved, A. terrigalensis has assumed economic importance because of the dermatitis it has caused among swimmers and other users of the estuary since the early 1960s. (Brunone-PTT)
W90-08729

EFFECTS OF SIX FOREST-SITE CONDITIONS ON NUTRIENT LOSSES IN EAST TEXAS.
State Forest Dept., Ipoh (Malaysia).
A. B. Muda, M. Chang, and K. G. Watterston.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 55-64, 1 fig, 4 tab, 22 ref.

Descriptors: *Environmental effects, *Forest watersheds, *Forestry, *Headwaters hydrology, *Logging, *Nutrient transport, Clear-cutting, Cultivation, Forest hydrology, Land clearing, Land use, Runoff, Soil erosion, Texas.

Surface and subsurface plot-watersheds were employed to monitor nutrient, water, and soil losses generated from six forest conditions in East Texas. Based on 23 runoff producing storms observed between June 21, 1980 and June 13, 1981, the total loss of nine nutrients was 2.33 kg/ha--undisturbed forest, 8.57 kg/ha--thinned forest, 18.18 kg/ha--clearcut without site preparation, 21.33 kg/ha--clearcut and chopped, 70.58 kg/ha--clearcut and sheared, and 46.65 kg/ha--cultivated treatments. Nutrient losses generally increased with an increase in the percentage of site disturbance. Clearcutting with chopping is a much better management practice in nonpoint sources of water pollution control than clearcutting and shearing. Differences in nutrient loss were insignificant between undisturbed and thinned forest, between clearcutting alone and clearcutting with chopping, or between clearcutting with shearing and clearcutting with cultivation. These losses can be estimated using total runoff in transformed covariance analysis models with an R square of 0.54 to 0.96. For the undisturbed forest, dissolved nutrients in runoff contributed 58.5% of the total nutrient losses, while suspended particulates and sediment contributed 40.4% and 1.1%. As forest disturbances increased, the relative importance of dissolved nutrients decreased and suspended nutrients increased. Only a small portion of nutrient loss, 1-12%, is from attached sediment. (See also W90-08822) (Author's abstract)
W90-08828

CUMULATIVE EFFECTS OF HUMAN ACTIVITIES ON BULL TROUT (SALVELINUS CONFLUENTUS) IN THE UPPER FLATHEAD DRAINAGE, MONTANA.
Montana Dept. of Fish, Wildlife and Parks, Kalispell.
J. Fraley, T. Weaver, and J. Vashro.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 111-120, 1 fig, 1 tab, 17 ref.

Descriptors: *Ecological effects, *Flathead Lake, *Headwaters hydrology, *Land use, *Spawning, *Trout, Environmental policy, Fish behavior, Fish passages, Fisheries, Hydroelectric power, Log-

ging, Riparian waters, Roads, Upper Flathead Drainage.

Bull trout are the largest fish native to the Flathead drainage area of Montana, attaining a length of up to one meter and a weight of 10 kg. This species migrates from Flathead Lake up to 250 km upstream to spawn in cold headwater tributaries with groundwater upwelling and clean gravels. Spawning and rearing habitats are limited and vulnerable to damage by deposition of fine sediments. Potential threats to bull trout habitat and populations include timber harvest, road building, mining, residential and agricultural development, hydropower construction and operation, harvest of fish by anglers, and non-native fish species. Management and mitigation options include application of best management practices and riparian guidelines for logging, habitat protection and improvement, improved fish passage to blocked areas, fishing regulations and integrative management of fish populations. Because of reduction in habitat, continued potential for habitat degradation, and limited options for management, the bull trout population is vulnerable and should be closely monitored to detect signs of decline. (See also W90-08822) (Author's abstract)
W90-08834

AGRICULTURAL MANAGEMENT AND POLICY NEEDS FOR SALINITY ABATEMENT IN EASTERN MONTANA.
Montana Salinity Control Association, Conrad.
For primary bibliographic entry see Field 5G.
W90-08837

EFFECTIVENESS OF BMP'S IN CONTROLLING NONPOINT POLLUTION FROM SILVICULTURAL OPERATIONS.
Pennsylvania State Univ., University Park. School of Forest Resources.
For primary bibliographic entry see Field 5G.
W90-08839

EFFECTS OF LAND USE ON SEDIMENT YIELD, SOUTHEASTERN COLORADO.
Geological Survey, Pueblo, CO.
For primary bibliographic entry see Field 2J.
W90-08846

GEOMORPHICALLY DETERMINED VALLEY-EROSION THRESHOLD FOR RECLAIMED SURFACE-MINED DRAINAGE BASINS, NORTHWESTERN COLORADO.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2J.
W90-08865

CUMULATIVE WATERSHED EFFECTS (CWE) ANALYSIS IN FEDERAL AND PRIVATE FORESTS IN CALIFORNIA.
Forest Service, South Lake Tahoe, CA. Lake Tahoe Basin Management Unit.
J. Cobourn.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 441-448, 24 ref.

Descriptors: *California, *Forest watersheds, *Headwaters hydrology, *Land ownership, *Watershed management, Management planning, Nonpoint pollution sources, Resources management, Water quality control.

Resource managers at the State and Federal forestry agencies in California are working to develop CWE analysis methodologies to satisfy legal requirements for consideration of cumulative impacts in watersheds of mixed ownership. The National Environmental Policy Act (NEPA) and the Clean Water Act of 1977, as well as the California Environmental Quality Act (CEQA), require that the effects of past, present, and future management activities be considered to prevent water quality impacts. Such analysis creates a safety net for water quality--the ultimate best management practice for predicting impacts which might be missed if planning were carried out only at the

project proposal level. Some of the most detailed CWE analyses in California are being performed by the hydrologists of the USDA Forest Service (USFS) using the Region 5 Forest Service methodology. Phase one of this approach is the calculation of a Natural Sensitivity Index for each watershed. Phase two is the compilation of the acreage of all management activities, including road surfaces, into a Land Disturbance History. In this phase, the Equivalent Roaded Acre (ERA) is often used as a unit of measure. Phase three is a field investigation, and phase four is an evaluation, based on Phases one, two, and three, of the possibility that the watershed may be at or near its geomorphic Threshold of Concern (TOC), beyond which special measures will be needed to ensure protection against adverse CWE. (See also W90-08822) (Author's abstract)
W90-08867

APPLICATION OF CUMULATIVE WATERSHED EFFECTS (CWE) ANALYSIS ON THE ELDORADO NATIONAL FOREST IN CALIFORNIA.
Forest Service, South Lake Tahoe, CA. Lake Tahoe Basin Management Unit.
J. Cobourn.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 449-460, 2 tab, 8 ref.

Descriptors: *California, *Environmental impact, *Forest watersheds, *Headwaters hydrology, *Land use, *National forests, *Watershed management, Administrative agencies, Forest management, Resources management, Sensitivity analysis.

The Region 5 Office of the USDA Forest Service has directed the National Forests of California to develop their own applications of the Region's 'Cumulative Off-site Watershed Effects Analysis' methodology. The Eldorado National Forest has developed and implemented such a process. Phase 1 of the process relies heavily on the Soil Survey and the Streamside Management Zones for calculation of a weighted Natural Sensitivity Index (NSI). The second phase of the analysis calls for the district offices to assemble the actual acreages and dates of various management activities, including proposed activities, in a Land Disturbance History (LDH). This summary uses the Equivalent Roaded Acre (ERA) as a unit of measure for normalizing the disturbance caused by various Harvest and Site Preparation activities. Phase 3, a detailed field observation of the channel system, is conducted if phases 1 and 2 indicate a need for concern. Once these phases are complete, phase 4, an estimate of the Threshold of Concern (TOC), is made. The estimated TOC is not a firm number but rather an approximation, such as 10-12% ERA for a very sensitive watershed. This TOC is only one part of a summary statement which attempts to explain management implications in terms of the degree of risk of initiating adverse CWE. (See also W90-08822) (Author's abstract)
W90-08868

CUMULATIVE HYDROLOGIC EFFECTS ON STORMFLOWS OF SUCCESSIVE CLEARCUTS ON A SMALL HEADWATER BASIN.
Pennsylvania State Univ., University Park. School of Forest Resources.
B. C. Dietterick, and J. A. Lynch.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 473-485, 2 fig, 3 tab, 15 ref.

Descriptors: *Clear-cutting, *Forest hydrology, *Forest management, *Headwaters hydrology, *Small watersheds, *Storm runoff, Flashy streams, Pennsylvania, Streamflow forecasting.

The hydrologic responses of small, forested watersheds to various forest management practices is the subject of continued interest. This study focused on the cumulative first-year effects on stormflow of successive clearcuts on an 106-acre watershed in central Pennsylvania. Inasmuch as clearcutting is

known to affect the hydrologic response of most watersheds, a series of prediction equations, developed from single storm hydrographs, were derived to estimate the effects of successive treatments on stormflow volumes and peakflows according to a paired watershed procedure. Seven years of streamflow records from the Leading Ridge Experimental Watersheds were used for the calibration period. Following the calibration period, three areas (21, 27, and 42 acres, respectively) moving progressively upslope on the treated watershed were clearcut and herbicided. The first-year cumulative effects of each of these treatments on stormflow volumes and peakflows were evaluated. The results indicate that significant cumulative increases in total stormflow volumes and peakflows occurred during the first-year growing season following each of the successive clearcuts; however, the increases were not directly proportional to the size of the area clearcut. This suggests that the flow regime temporarily became progressively more 'flashy' and had significantly higher sustained water yields. It also indicates a potential threat to the benthic community of these small streams due to increased sedimentation from channel scouring. (See also W90-08822) (Author's abstract) W90-08870

PROGRESSIVE, LONG-TERM SLOPE FAILURE FOLLOWING ROAD CONSTRUCTION AND LOGGING ON NONCOHESIVE, GRANITIC SOILS OF THE IDAHO BATHOLITH.
Intermountain Forest and Range Experiment Station, Boise, ID.
W. F. Megahan, and C. C. Bohn.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 501-510, 5 fig, 2 tab, 12 ref.

Descriptors: *Cohesionless soils, *Headwaters hydrology, *Highway effects, *Logging, *Slope stability, Experimental basins, Forest management, Groundwater movement, Idaho.

Catastrophic failures of steep, forested slopes that result in debris avalanches, flows, and torrents are common occurrences following logging and road construction in the Idaho Batholith. However, piping failures caused by progressive, small-scale liquefaction of the cohesionless, granitic soil materials have not been well documented to date. Since 1984, three such failures were studied on three experimental watersheds in the Silver Creek Study Area. The failures are located in small (1.6 to 5.4 ha) first-order basins best described as low-gradient swales that lacked surface expression of channel development before failure. Two of the failures appear to have been caused by clearcut logging in 1976 and 1982; the third was caused by road construction in 1980. To date, the failure lengths range from 13 to 38 m and have a total volume of soil loss ranging from 6 to 39 cu m. The total erosion from the failures accounts for an average of 1 to 25% of the postdisturbance sediment yield and an annual maximum of 2 to 56% of the sediment yield from the 1.1 to 1.6 sq km study watersheds. Annual erosion rates appear to be related to the annual peak runoff from the experimental watersheds which in turn serves as an index of groundwater conditions. Such failures are important because they are forest management related, continue over a long term, are not easily detected, and may supply eroded material directly to the drainage system. (See also W90-08822) (Author's abstract) W90-08872

HYDROLOGIC CHARACTERISTICS OF A WETLAND USING A BROMIDE TRACER.
Peccia (Robert) and Associates, Helena, MT.
For primary bibliographic entry see Field 5B.
W90-08877

EFFECT OF MINING ON WATER QUALITY.
Arizona Dept. of Environmental Quality, Phoenix.
C. Hains, and D. Hains.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 637-644, 6 fig, 1 tab, 8 ref.

Descriptors: *Headwaters hydrology, *Land use, *Mine wastes, *Mining effects, *Model studies, *Water pollution sources, *Water quality, Geohydrology, Mathematical models, Regression analysis, Streamflow.

Results are given from a preliminary model which relates water quality, streamflow, and degree of disturbance of a watershed by a method that is simple for planners, regulators, and hydrologists to apply. This preliminary model is applicable to watersheds with constant geology. Research is underway to extend this technique to include geology to provide a model useful to watersheds of heterogeneous geology. The linear regression technique was used to develop the model and it should be applicable anywhere calibration data are available. The model yields the coefficients of the rating equation relating water quality, as measured by specific conductance or total suspended solids, with discharge per unit area. These coefficients depend on the degree of disturbance of the basin. Degree of disturbance for study watersheds was determined on a qualitative basis from direct field observations and of aerial photography from each mine. Each site had an integer value of disturbance assigned ranging from 1 to 6. The degree of disturbance was classified as follows: (1) essentially unmined (no disturbance); (2) slight (10-30%); (3) slight to moderate (31-50%); (4) moderate (51-70%); (5) moderately large (71-90%); and (6) completely disturbed. The degree of disturbance will normally be 6 for a mine permit area as typical for 90% or more percent of the permit area to be disturbed. (See also W90-08822) (Lantz-PTT) W90-08886

POTENTIAL SOURCES OF GROUNDWATER CONTAMINATION IN THE HEADWATERS OF THE MAHANTANGO CREEK.
Agricultural Research Service, University Park, PA. Northeast Watershed Research Center.
For primary bibliographic entry see Field 5B.
W90-08889

EFFECTS OF SURFACE MANAGEMENT ON THE HYDROLOGY OF A VERTISOL IN SEMI-ARID AUSTRALIA.
Queensland Dept. of Primary Industries, Bundaberg (Australia).
For primary bibliographic entry see Field 3F.
W90-08916

WATER USE BY SHRUBS AS AFFECTED BY ENERGY EXCHANGE WITH BUILDING WALLS.
Texas A and M Univ., College Station. Dept. of Soil and Crop Sciences.
For primary bibliographic entry see Field 2I.
W90-08925

SELECTIVE OAK REMOVAL DOES NOT HARM WATER QUALITY.
California Univ., Davis. Dept. of Land, Air and Water Resources.
M. J. Singer, X. Huang, and C. Epifanio.
California Agriculture CAGRA3, Vol. 44, No. 2, p 17-19, March/April 1990. 2 fig, 2 tab.

Descriptors: *Forest hydrology, *Forest watersheds, *Oak trees, *Water pollution sources, *Water quality, *Water yield, Nitrates, Nutrient transport, Rainfall-runoff relationships, Range production, Runoff, Sediment transport.

The uppermost portions of a perennial stream watershed in the Sierra Foothills, California was cleared of all trees between 1964 and 1966 to enhance range production. The selective removal of oaks resumed between 1984 and 1986. An average of 27.5 inches of rainfall was measured in the watershed during the last nine years. Rainfall and runoff were higher in the four precut years than in the postcut years. There is a possibility that selective oak removal may yield a long-term increase in water yield. The amount of sediment leaving the watershed is very small and was not adversely affected by oak harvesting. There were no significant differences between the precut and the post-

cut sums of cations (calcium, magnesium, potassium, and sodium) leaving the watershed. Nitrate nitrogen in runoff and rainfall was significantly higher in postcut years. The total nutrients lost from the watershed was small and present no water quality hazards. (Brunone-PTT) W90-08936

WATER QUALITY IN SOUTHEASTERN MINNESOTA STREAMS: OBSERVATIONS ALONG A GRADIENT OF LAND USE AND GEOLOGY.
Minnesota Univ., St. Paul. Dept. of Forest Resources.
N. H. Troelstrup, and J. A. Perry.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 6-13, Fall 1989. 5 fig, 1 tab, 52 ref.

Descriptors: *Land use, *Minnesota, *Water pollution sources, *Water quality trends, Agricultural watersheds, Alkalinity, Atrazine, Forest watersheds, Nitrates, Pesticides, Riparian waters, Streamflow, Water quality management, Watersheds.

Surface water quality in southeastern Minnesota's driftless area exhibits subregional and local spatial patterns which are highly correlated with subsurface geology and land-use practices. Some variables appear to respond on subregional or watershed scales. Intensive sampling was conducted at twelve riffle sites within three tributaries of the south branch of the Root River in Fillmore County. Measurements included a large number of physical parameters, chemical parameters, and biological variables. Nitrate, specific conductance, alkalinity, and surface water atrazine concentrations were lower in streams originating from the Prairie Du Chien or Jordan sandstone aquifers of eastern Fillmore and Houston Counties than those originating from the Galena limestone aquifer in west-central Fillmore County. In addition, the numbers of pollution intolerant and functionally specialized invertebrates in the benthic community were higher in the eastern streams. Gross primary production on tile substrates, transported organic matter, and atrazine concentrations were highest in an agricultural watershed and lowest in a forested watershed. Other variables are more responsive to local influences such as riparian land use. Substrate median particle size, macrophyte composition on riffles, diversity of benthic invertebrates, and number of invertebrate predators were highest on riffles adjacent to forested riparian zones. Stream temperature and turbidity were higher at riffle sites adjacent to open agricultural riparian zones. The water quality patterns in southeastern Minnesota suggest that effective monitoring and management of water quality in this ecoregion must consider a finer spatial scale than that suggested by the aquatic ecoregion approach. (Author's abstract) W90-08970

ORIGIN AND DEVELOPMENTAL HISTORY OF MINNESOTA LAKES.
For primary bibliographic entry see Field 2H.
W90-08973

HUMAN IMPACTS TO MINNESOTA WETLANDS.
Minnesota Univ.-Duluth. Natural Resources Research Inst.
C. A. Johnston.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 120-124, Fall 1989. 1 fig, 2 tab, 49 ref.

Descriptors: *Drainage, *Drainage effects, *Environmental impact, *Minnesota, *Urbanization, *Wetlands, Flood flow, Nonpoint pollution sources, Nutrients, Peat bogs, Sediments.

Minnesota's 3.6 million ha of wetlands have been impacted by a variety of human activities, including agricultural drainage, urbanization, water control, and nonpoint source pollution. More than half of Minnesota's wetlands have been destroyed since the first European settlers arrived, an average loss of about 35,600 ha/yr. Drainage for agriculture is

the major cause of wetland loss in Minnesota, particularly in southern Minnesota and the Red River valley. In addition to impacting wetlands directly, wetland drainage affects downstream areas by increasing flood flows and releasing sediment and nutrients. Urban development and highway construction affect a smaller proportion of Minnesota's wetlands, but substantially alter their physical, chemical, and biological properties. Hydrology has a major influence on the structure and function of wetlands, so changes in the frequency, duration, depth, and timing of wetland flooding can severely impact wetlands. While wetlands can assimilate low levels of sediment and nutrient enrichment, excessive inputs can be detrimental. Peat harvesting is not currently extensive in Minnesota, but could cause substantial impacts. Cumulative impact, the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions, is becoming an area of increasing concern. (Author's abstract)
W90-08988

LAND USE CHANGES AND INPUTS OF NITROGEN TO LOCH LEVEN, SCOTLAND: A DESK STUDY.
Edinburgh School of Agriculture (Scotland).
S. P. Cuttle.
Agricultural Water Management AWMADF, Vol. 16, No. 1/2, p 119-135, August 1989. 4 fig, 2 tab, 38 ref.

Descriptors: *Agricultural runoff, *Land use, *Nitrogen, *Nonpoint pollution sources, *Scotland, *Water pollution sources, Eutrophication, Fertilizers, History, Lakes, Loch Leven, Nutrients, Path of pollutants.

Published and unpublished data were used to examine land use changes in the Loch Leven catchment and to estimate annual inputs of N to the loch for five-yearly intervals between 1950 and 1985. Agricultural land (38% grass, 31% arable, and 31% rough grazing) was identified as the major source of N entering the loch. The input from this source was estimated to have increased from 171 t N/yr in 1950 to 321 t N/yr in 1985. This increase was primarily a result of increased use of N fertilizer. Nitrogen from livestock wastes and that released following ploughing of grassland also made a significant contribution, but only that from livestock increased during the study period. The greatest increase in fertilizer use was in the quantities applied to grassland but because of the relatively low leaching losses associated with this land use, losses from arable land in all years were higher than those from grassland. Total inputs of N to the loch were estimated to have increased from 208 to 368 t N/yr between 1950 and 1985, equivalent to an increase in the average concentration of drainage water from 1.7 to 3.0 mg N/L. There was approximate agreement between the estimates for later years of the study period and corresponding values derived from field measurements. (Author's abstract)
W90-09014

PRACTICAL APPLICATION OF THEORY FOR TIDAL-INTRUSION FRONTS.
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 8I.
W90-09127

DESTRUCTION OF SPAWNING GROUNDS OF MAHSEER AND OTHER FISH IN GARHWAL HIMALAYAS.
Garhwal Univ., Srinagar (India). Dept. of Zoology.
P. Nautiyal, and M. S. Lal.
Journal of the Bombay Natural History Society JBOMAA, Vol. 85, No. 2, p 311-314, August 1988. 1 fig, 9 ref.

Descriptors: *Aquatic habitats, *Ecological effects, *Endangered species, *Environmental effects, *Fish, *Himalayan Mountains, *Spawning, *Streams, Alaknanda River, Fish migration, Fishing, Ganges River, Gravel, Habitats, Hydroelectric power, India, Mahseer, Migration, Mountain streams, Nayar River, River beds, Stream fisheries.

Observations of the mahseer population in streams of the Garhwal Himalayas of India revealed small numbers of only two species. The depletion of the once-popular sport fish was attributed to problems during migration from the Ganges to the Alaknanda and Nayar rivers. During their travels they have been exposed to a hydroelectric project, severe fishing pressure, fish traps, and use of explosives. In addition, it was reported that the stream beds which serve as spawning grounds have been repeatedly disturbed by persons removing truckloads of stones for building projects. (Cassar-PTT)
W90-09194

NITRATE CONTAMINATION OF GROUNDWATER IN NORTH AMERICA.
Agricultural Research Service, Lincoln, NE.
For primary bibliographic entry see Field 5B.
W90-09256

NITRATE POLLUTION OF GROUNDWATER IN WESTERN EUROPE.
Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W90-09257

IMPACT OF AGRICULTURAL PRACTICES ON GROUNDWATER SALINITY.
Agricultural Research Service, Riverside, CA. Salinity Lab.
D. L. Suarez.
Agriculture, Ecosystems and Environment AEENDO, Vol. 26, No. 3/4, p 215-227, October 1989. 3 fig, 30 ref.

Descriptors: *Agriculture, *Groundwater management, *Groundwater quality, *Nonpoint pollution sources, *Saline groundwater, *Surface-groundwater relations, *Water pollution sources, Conjunctive use, Irrigation, Literature review, Salinity, Water resources management.

The effects of agricultural practices on groundwater salinity were reviewed. The impact of agricultural practices on water quality has been examined predominantly with an emphasis on surface water. Impacts on groundwater, as compared with surface waters, are much more difficult to quantify. This is due to larger travel times to and in groundwater as compared with surface waters and to difficulty in sampling groundwater properly. Despite these difficulties in quantification, the impacts on groundwater and surface waters are equally important. In non-irrigated areas, agriculture often leads to increased recharge, sometimes resulting in the leaching of salts from the unsaturated zone into groundwater. In irrigated areas, groundwater salinization can result from irrigation with saline water, salt water intrusion owing to pumping of groundwater, downward movement of salts in the unsaturated zone, or dissolution of saline minerals, and from the unavoidable concentration of salts due to plant water uptake. The interrelationship of surface and groundwater must involve water quality as well as quantity. Optimization of water resources entails consideration of conjunctive use, which in turn requires consideration of water quality in all parts of the system. Examples showing how improvements made to reduce river salinity can cause groundwater salinization are presented. (Author's abstract)
W90-09258

GROUNDWATER CONTAMINATION BY TRACE ELEMENTS.
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 5B.
W90-09259

EFFECTS OF ARTIFICIAL CIRCULATION ON HYPEREUTROPHIC LAKE.
Metropolitan Council, St. Paul, MN.
For primary bibliographic entry see Field 5G.
W90-09344

CHANGING RAINFALL-RUNOFF RELATIONSHIPS IN THE URBANIZING PEACHTREE CREEK WATERSHED, ATLANTA, GEORGIA.
Georgia Univ., Athens. School of Environmental Design.
B. K. Ferguson, and P. W. Suckling.
Water Resources Bulletin WARBAQ, Vol. 26, No. 2, p 313-322, April 1990. 4 fig, 3 tab, 20 ref.

Descriptors: *Atlanta, *Georgia, *Rainfall-runoff relationships, *Urban hydrology, *Urban runoff, *Urbanization, Evapotranspiration, Flood peak, Landscaping, Low flow, Peachtree Creek, Storm runoff, Vegetation.

Peachtree Creek is a gaged watershed that has experienced a substantial increase in urbanization. The relationships of runoff to rainfall were studied for total annual flows, low flows, and peak flows. For each type of flow the relationship in the later, more urbanized period was compared to that in the earlier, less urbanized period. An increase in total runoff in wet years was observed as urbanization increased, but a decrease occurred during dry years. For low flows a similar decrease of runoff in dry years was found. An increase in peak runoff was observed over most of the range of precipitation. Increasing peak flows and declining low flows can be adequately explained by urban hydrologic theory, which focuses on the effects of urban impervious surfaces upon direct runoff and infiltration. However, a decline of total runoff in dry years can be explained only by taking into account evapotranspiration as well. The concept of advectively assisted urban evapotranspiration, previously discovered by climatologists, is needed to explain such a loss of total runoff. Urban hydrologic theory must take into account vegetation and evapotranspiration, as well as impervious surfaces and their direct runoff, to explain the magnitude of total annual flows and low flows. Urban storm water management should address the restoration of low flows, as well as the control of floods. (Author's abstract)
W90-09355

HERBICIDE CONCENTRATION PATTERNS IN RIVERS DRAINING INTENSIVELY CULTIVATED FARMLANDS OF NORTHWESTERN OHIO.
Heidelberg Coll., Tiffin, OH. Water Quality Lab.
For primary bibliographic entry see Field 5B.
W90-09448

IMPACT OF CONSERVATION TILLAGE AND PESTICIDE USE ON WATER QUALITY: RESEARCH NEEDS.
North Carolina State Univ., Raleigh. Dept. of Biological and Agricultural Engineering.
W. S. Berryhill, A. L. Lanier, and M. D. Smolen.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 397-404, 1 fig, 5 tab, 13 ref.

Descriptors: *Agricultural runoff, *Agriculture, *Environmental effects, *Pesticides, *Research priorities, *Tillage, *Water pollution sources, *Water quality, Sediment contamination, Soil loss, Surface runoff.

No-till and reduced-till practices, where residue cover is at least 30%, on average reduces sediment concentration by 66%, soil loss by 81%, and surface runoff by 31%. This can reduce pesticide losses in runoff and eroded soil but may be offset by heavier use of pesticides in conservation tillage systems. Generally the effect of conservation tillage on pesticide losses is poorly defined. A more systematic approach to the study of water-quality effects of conservation tillage and pesticide use is recommended to obtain data on (1) different physical settings (soils, regions, etc.) and entire watersheds, (2) persistence of pesticides in soils and ground water, (3) losses to the atmosphere and subsequent redeposition, and (4) development and verification of models. A more unified approach to conservative tillage research, including a standard format for reporting results, will lead to a better

understanding of the relationship of conservation tillage to pesticide pollution in NPS control programs. (See also W90-09440) (Author's abstract) W90-09469

IMPACTS OF FORMER COAL GASIFICATION PLANTS IN A NUMBER OF HYDROGEOLOGIC ENVIRONMENTS.

Canviro Consultants Ltd., Waterloo (Ontario).
R. B. Whiffin, and D. W. Belanger.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 137-150, 2 fig, 1 tab, 16 ref.

Descriptors: *Coal gasification, *Environmental effects, *Geohydrology, *Path of pollutants, *Water pollution sources, Groundwater movement, Hydraulic gradient, Industrial wastes, Ontario.

The impact of coal gasification plant wastes on groundwater was determined through conducting geohydrological investigations at nine (9) former plant sites. The sites were located in a variety of hydrogeological environments including fluvial sands, glacial till, fractured limestone and glacial moraine/outwash deposits. Studies focused on the presence of coal tar, a waste product of primary concern from an environmental perspective due to the high levels of polynuclear aromatic hydrocarbons. Because coal tar is a dense immiscible fluid, it became the key consideration in the development of the investigative approach in order to minimize the spread of contamination. Other organic and inorganic contaminants derived from coal tar were also considered. The migration of coal tar as an immiscible phase occurs only when it accumulates to a critical height sufficient to overcome capillary and viscous forces. Conditions conducive to coal tar migration at most sites occur only in the presence of coarse grained soil. Fine grained soils trap immiscible coal tar preventing migration through this strata. Extensive migration of tar will occur only when the critical height was maintained at the source (i.e. leaky gas holder or tar well) and may be enhanced when a very high hydraulic gradient exists. (See also W90-09479) (Lantz-PTT) W90-09490

ANALYSIS OF RECENT DATA REGARDING GROUNDWATER CONDITIONS OF NASSAU COUNTY, NEW YORK.

GeoTrans, Inc., Harvard, MA.
J. H. Guswa, P. F. Andersen, and T. V. Whiteside.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 359-374, 7 fig, 2 tab, 15 ref.

Descriptors: *Environmental effects, *Groundwater depletion, *Groundwater resources, *Nassau County, *Urbanization, *Water pollution sources, Chlorides, Geohydrology, Groundwater budget, New York, Streamflow.

Groundwater is the sole source of water supply to Nassau County which is located in the west central portion of Long Island. During the period immediately following World War II until the mid-1960s, this part of Long Island experienced rapid urbanization. The rate of urbanization declined significantly after the mid-1960s but the effects of urbanization and sewering on the groundwater flow system continued into the 1970s. Concerns have been expressed that the trends of groundwater level and streamflow change observed in the 1960s and early 1970s are continuing, resulting in a depletion of the groundwater resources. In 1987, the Long Island Water Conference and Long Island Water Corporation funded a project to review existing geohydrologic information for the purpose of evaluating recent trends in hydrologic conditions in Nassau County. Data review and analyses included groundwater level data, streamflow data, and groundwater chloride concentration data. Water level data from about 300 wells and long-term hydrographs for about 100 wells indicated that, since the early 1970s, the groundwater system

has attained a new condition of dynamic equilibrium. Analysis of chloride concentration data from over 65 wells near the freshwater/saltwater transition zone in southwestern Nassau County showed a general stability of chloride concentrations since data collection began, in 1960. Streamflow data from nine Nassau and Suffolk County streams showed that a marked reduction in Nassau County stream baseflow began in the late 1950s and continued to about 1970. Analysis of flow duration curves indicate that urbanization has significantly altered streamflow characteristics between the late 1940s (1946-1950) and early 1970s (1970-1974). Only minor changes in streamflow characteristics were noted from the early 1970s to the four-year period 1978-1982. Compilation and analysis of recent data indicate that the groundwater system underlying Nassau County is in a condition of dynamic equilibrium where recharge and discharge are in balance. Although the data indicate that the hydraulic trends of the 1960s have not continued to the present, Nassau County must continue to monitor and manage its valuable groundwater resources. (See also W90-09479) (Author's abstract) W90-09505

CUMULATIVE IMPACTS OF LAND DEVELOPMENT WITHIN WELLHEAD PROTECTION AREAS: ASSESSMENT AND CONTROL.

Horsley, Witten and Hegemann, Inc., Cambridge, Ma.
C. A. Coughanowr, J. D. Witten, and S. W. Horsley.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 407-421, 1 fig, 1 tab, 3 ref.

Descriptors: *Environmental protection, *Regulations, *Urbanization, *Water pollution control, *Water quality control, *Water resources management, Land use, Nitrates, Nitrogen, Waste disposal, Zoning.

The management of wellhead protection areas (WHPAs) has received increasing emphasis over the past ten years. Typical protection strategies include the development of overlay zoning districts within which specific potentially hazardous uses are prohibited, including: landfills, industries or businesses using or producing hazardous materials, underground fuel storage tanks, sewage treatment plants, and salt storage areas. Another common approach in protecting wellhead protection areas is to require Environmental Impact Reports for large proposed development projects which exceed specific thresholds. Although these protection strategies are clearly a valuable first step, they do not address cumulative impacts of land development within wellhead protection areas over time. Groundwater contamination from dispersed, non-point residential and agricultural uses can contaminate public water supplies as effectively as a poorly-sited landfill. A particularly difficult issue to resolve, in controlling land use within WHPAs is that of 'grandfathered' lots. In order to address the reality of this programmed growth and to control cumulative impacts of land development within wellhead protection areas over time, a technical and regulatory approach, which is outlined in this paper, has been developed. This methodology is designed to evaluate and control cumulative nitrate-nitrogen concentrations in groundwater, and follows a 4-step methodology: (1) define wellhead protection areas; (2) establish nitrate-nitrogen planning guidelines; (3) conduct a developable lot analysis of WHPA; and (4) conduct nitrogen loading analysis. Following this analysis, and based upon the results, regulatory techniques can be implemented such as zoning, sub-division control, and sewage disposal regulations. Non-regulatory techniques for zoning and subdivisions, and legislative techniques, also need to be considered throughout this type of evaluation. (See also W90-09479) (Lantz-PTT) W90-09508

4D. Watershed Protection

EVALUATING A BANK STABILIZATION PROJECT 25 YEARS AFTER COMPLETION.

White Mountain National Forest, Laconia, NH.
R. S. Ferrin, and J. W. Staats.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 95-99, 3 tab, 4 ref.

Descriptors: *Bank stabilization, *Gabions, *Headwaters hydrology, *Riprap, Bank protection, Channel improvement, Erosion control, Zealand River.

Zealand River, a headwater tributary to the Connecticut River, drains a steep basin in the White Mountain National Forest of northern New Hampshire. A severe flood in October 1959 caused considerable bank damage, aggradation, and channel change. Following a stream condition survey in 1960, gabions and riprap were prescribed for restoration of the stream channel. Beside repairing bank damage, the objectives of the project were: (1) to study techniques of gabion and riprap placement, and (2) to evaluate the effectiveness and durability of those techniques. Installation of riprap walls, gabion walls, and gabion sills in 2.5 miles of river was made from 1961 to 1963. In 1974 an assessment of the gabions was made because of the damages caused by the June 1973 flood. In 1988, the gabions, riprap, and streambanks were inspected and mapped to ascertain their condition. The gabions walls failed at high energy points in the river or where the channel was too constricted. Gabion sills were obliterated by the river's massive bedload movement. Even 25 years after placement, the remaining gabion walls still do not fit the character of the surrounding landscape, while the riprap is natural appearing. Effectiveness and durability of the gabions and riprap are evaluated. Future management of the gabions, especially when frugal budgets are a necessity, should be very minimal and should include at most removal of empty and accessible gabion baskets, removed of wire, and release of leaning gabions to prevent a domino effect. Vegetation growing in or adjacent to any of the stabilization measures should be left to natural processes. (See also W90-08822) (Author's abstract) W90-08832

CHANNEL EROSION ANALYSIS AND CONTROL.

Army Engineer District, Omaha, NE.
For primary bibliographic entry see Field 2J.
W90-08833

FOREST HEADWATERS RIPARIAN ROAD CONSTRUCTION AND TIMBER HARVEST GUIDELINES TO CONTROL SEDIMENT.

Bitterroot National Forest, Hamilton, MT.
R. G. Hammer.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 127-131, 1 fig, 2 photo, 2 ref.

Descriptors: *Forest watersheds, *Headwaters, *Headwaters hydrology, *Riparian land, *Sediment control, Bank stabilization, Detritus, Erosion control, Log steps, Sedimentation, Slash windrows.

Two major principles to control forest headwaters sediment are to minimize sediment from road construction and to maintain woody debris stream structures such as log steps which store sediment. Guidelines for road construction in riparian areas include slash filter windrows at the toe of road fill slopes. Studies indicate that slash filter windrows trap 75% or more of road sediment at low cost. Guidelines for timber harvest in riparian areas include provision for large woody debris recruitment to headwater streams. Forest headwater stream channels are dependent upon woody materials to form log steps which store sediment, dissipate

stream energy, and provide fish habitat. (See also W90-08822) (Author's abstract)
W90-08836

FLUME STUDY EXAMINING THE FILTERING EFFICIENCY OF SILT FENCES USING SITE-SPECIFIC SOILS.
Utah Dept. of Natural Resources, Salt Lake City. Div. of Oil, Gas and Mining.
T. Munson.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 431-440, 6 fig, 2 ref.

Descriptors: *Filter media, *Flumes, *Headwaters hydrology, *Sediment control, *Silt fences, Coal mining, Soil types, Utah, Water quality.

The use of silt fences and various other alternative sediment controls is a common practice in the coal mining areas of Utah to control erosion and sedimentation of streams. Through the use of a flume, site-specific data was collected to assess the filtering efficiency and water quality changes attributed to various silt fence fabrics using site-specific mine soils--a sandy soil from the Deer Creek Mine facility in central Utah and a clayey soil from the proposed Alton Mine site in southern Utah. A total of seven filtering runs were completed for each mine site. The results show filtering efficiencies of greater than 90 percent on four runs for the Deer Creek soils, and on one run for the Alton Mine soils. The initial suspended solids data was extremely variable between runs on the same soil type. When water quality is a crucial issue, it is possible that impacts from using silt fences for sediment control can be calculated by looking at a specific soil type, calculating initial suspended solids values for that soil type, and determining the final composite suspended solids results based on flume studies. A percentage of the fine particles that pass through the fabrics remain in suspension and can be considered a potential impact to water quality when clayey soils are filtered. (See also W90-08822) (Shidler-PTT)
W90-08866

BASELINE RISK ASSESSMENT: A CONVINCING CUMULATIVE EFFECTS ANALYSIS IN THE BULL RUN WATERSHED.
Forest Service, Troutdale, OR. Columbia Gorge Ranger District.
C. M. Athman, and B. P. McCammon.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 461-471, 3 fig, 3 tab, 13 ref.

Descriptors: *Environmental impact, *Forest management, *Headwaters hydrology, *Land use, *Logging, *Oregon, *Risk assessment, *Water quality criteria, *Watershed management, Baseline studies, Regression analysis, Water supply.

The Bull Run Watershed, which is the water supply for the City of Portland, Oregon, is currently undergoing salvage logging as a result of a December 1983 wind storm. Based on review of past studies, trend and multiple regression analyses, it was concluded that past management activity levels did not significantly alter water quality or flow response. It was then assumed that if future management (i.e., salvage logging) did not exceed past management levels, acceptable water quality would result. A risk hazard rating process was developed to assure that risks from proposed salvage activities did not exceed risks from past management. The process also assessed terrain similarity and erosion sensitivity. The risk ratings are used to determine the most likely form of erosion to occur in the area: surface erosion or mass failure. Specific recovery curves distribute the potential effect of activities over time. Activities considered and compared to the past management were: clearcut harvest, road construction and watershed entry days. With this process, it was possible to compare past management with the proposed activity and validate the necessary assumptions for this cumulative water quality assessment technique. (See also W90-08822) (Author's abstract)

W90-08869

MANAGEMENT OF BASEFLOW AUGMENTATION: A REVIEW.
San Diego State Univ., CA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3B.
W90-09350

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

EFFECTS OF ATRAZINE ON MICROCOSMS DEVELOPED FROM FOUR NATURAL PLANKTON COMMUNITIES.
Environmental Research Lab.-Duluth, MN.
For primary bibliographic entry see Field 5C.
W90-08652

ANALYSIS OF SIX FORAGING BEHAVIORS AS TOXICITY INDICATORS, USING JUVENILE SMALLMOUTH BASS EXPOSED TO LOW ENVIRONMENTAL PH.
State Univ. of New York at Syracuse. Coll. of Environmental Science and Forestry.
J. Hill.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 6, p 895-899, November 1989. 1 fig, 1 tab, 38 ref.

Descriptors: *Acid rain effects, *Acidic water, *Bass, *Bioindicators, *Ecotoxicology, *Fish behavior, *Hydrogen ion concentration, *Toxicity, *Water pollution effects, Bioassay, Daphnia, Predation, Sublethal effects, Tubificids.

Six foraging behaviors were evaluated for use in toxicity bioassays with fishes. Response time and strike frequency were used to measure fish activity, average and longest fixation distance, were used to measure visual acuity, while prey capture frequency and strike success were used to measure fish coordination and agility. In this study, the feeding behaviors were used to evaluate the effects of chronic exposure to acidic water on juvenile smallmouth bass (Micropterus dolomieui). Feeding responses to two types of live prey, tubificids and Daphnia magna, were recorded for bass exposed to pH 4.7 and 4.2. Fish held at the lower pH level had significantly lower fixation distances, prey capture success and capture frequencies with both prey types, indicating that high levels of acidity may impair visual acuity, coordination, and agility. The foraging behavior evaluated herein appear to be useful in toxicity testing because they are easily quantified and indicate changes that may affect growth and survival in long-term exposures. (Author's abstract)
W90-08654

HIGH PERFORMANCE LIQUID CHROMATOGRAPHIC SEPARATION OF FISH BILIARY POLYNUCLEAR AROMATIC HYDROCARBON METABOLITES.
Virginia Inst. of Marine Science, Gloucester Point.
A. D. Deshpande.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 6, p 900-907, November 1989. 5 fig, 2 tab, 40 ref.

Descriptors: *Chromatography, *Fish, *High performance liquid chromatography, *Metabolites, *Path of pollutants, *Pollutant identification, *Polycyclic aromatic hydrocarbons, *Separation techniques, Bile, Elizabeth River, Estuaries, Laboratory methods, Toxicology, Virginia.

Polycyclic aromatic hydrocarbons (PAHs) are believed to exert harmful effects in fish through metabolic activation, mediated by the hepatic microsomal mixed function oxygenase (MFO) enzyme system. A modification of Krahn's procedure for the high performance liquid chromatographic (HPLC) separation of fish biliary PAH meta-

bolites was examined by using three C-18 columns in tandem, eluted with a mobile phase gradient of 100% water to 100% acetonitrile in 240 minutes. By following the modified procedure, the bile of spot (Leiostomus xanthurus), Atlantic croaker (Micropogonius undulatus), weakfish (Cynoscion regalis), hogchoker (Trinectes maculatus) and oyster toadfish (Opsanus tau) from the PAH-polluted Southern Branch of the Elizabeth River, VA, gave rise to large numbers of reasonably well resolved PAH metabolite peaks compared to the control Nansemond River fish. The separation of fish biliary PAH metabolites, without elaborate sample extractions (an important feature of Krahn's procedure), indicate the possibility of direct detection and quantification of critical metabolites by HPLC and HPLC/mass spectrometry (HPLC/MS). (Author's abstract)
W90-08655

MONITORING OF PERSISTENT, LIPOPHILIC POLLUTANTS IN WATER AND SEDIMENT BY SOLVENT-FILLED DIALYSIS MEMBRANES.
Lund Univ. (Sweden). Dept. of Ecology.
A. Sodergren.
Ecotoxicology and Environmental Safety EESADV, Vol. 19, No. 2, p 143-149, April 1990. 3 fig, 1 tab, 9 ref.

Descriptors: *Dialysis, *Laboratory methods, *Lipids, *Monitoring, *Pollutant identification, *Semipermeable membranes, *Solvents, *Water quality, Bioaccumulation, Chlorinated hydrocarbons, Indicators, Path of pollutants, Water quality control.

Owing to their low levels in the water, the presence of persistent, lipophilic pollutants is usually monitored by analysis of fatty tissues of aquatic organisms. Dialysis membranes filled with solvents are passive samplers that can be used to monitor these lipophilic pollutants in marine and fresh water environments, to predict levels of bioavailable compounds in organisms, and to study bioaccumulation mechanisms. The membranes are filled with n-hexane and exposed for 1 to several weeks in the water or in the sediment. The solvent impregnates the membrane, making it unsuitable for periphyton growth, and prevents bacterial degradation. The membranes can also be used in environments too polluted for biological indicators to survive. The use of membranes with a molecular weight cutoff of 1000 Daltons prevents substances of higher molecular weight from diffusing through their walls, thereby simplifying the cleanup procedure. Internal standards in the solvent can be quantified to ensure that the membrane functions properly during exposure. Uptake and depuration of organochlorine residues by the membranes seem to be governed by equilibrium partitioning. (Author's abstract)
W90-08667

DETERMINATION OF POLAR PESTICIDES BY GAS CHROMATOGRAPHY IN DRINKING AND NATURAL WATER.
Gelsenwasser A.G., Gelsenkirchen (Germany, F.R.). Abt. Wasserchemie.
V. C. Schlett.
Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 23, No. 1, p 32-35, February 1990. 7 fig, 1 tab, 13 ref. English summary.

Descriptors: *Chromatography, *Drinking water, *Organochlorines, *Pesticides, *Pollutant identification, *Water analysis, *Water pollution, Detection limits, Diazomethane, Mass selective detector.

A method is described for the determination of polar pesticides in water after extraction on carbon-18 reversed phase material and reaction with diazomethane. The analytical method and the characteristic and operational date are described for the substances Ioxynil, Bromoxynil, Bentazon, CMPA, CMPB, CMPP (Mecoprop),2,4-D, 2,4-DB, 2,4-DP (Dichlorprop), 2,4-5-T and 2,4,5-TP (Fenoprop). The determination limit is 0.025 micrograms/L by using a mass selective detector. The range of variation for recovery is between 80

and 130%. For six other substances (Clopyralid, Dicamba, Triclopyr, Dinoseb, Picloram, and Pentachlorphenol), only the chromatographic conditions are reported. (Author's abstract)
W90-08696

COMPARISON OF BIOTIC INDEX VALUES FOR INVERTEBRATE COLLECTIONS FROM NATURAL AND ARTIFICIAL SUBSTRATES.
South Dakota State Univ., Brookings. Dept. of Wildlife and Fisheries.
T. Modde, and H. G. Drewes.
Freshwater Biology FWBLAB, Vol. 23, No. 2, p 171-180, April 1990. 3 fig, 5 tab, 24 ref.

Descriptors: *Artificial substrates, *Bioindicators, *Limnology, *Macroinvertebrates, *Pollutant identification, *Species diversity, Benthic invertebrates, Colonization, Diversity indices, North Dakota.

Biotic indices have been proposed as an alternative means of evaluating the response of macroinvertebrates to environmental conditions. The use of a biotic index in a small mountain stream in South Dakota was evaluated on the basis of collections of benthic macroinvertebrates from both artificial and natural substrates in years of above and below normal discharge. Benthic macroinvertebrates were collected from each station at 3-week intervals in 1981 and 1982. Hester-Dendy artificial substrate samplers were left in for six weeks prior to removal. The biotic index calculated from the benthos data differed significantly between years. The mean for all stations was 2.76 in 1981, which was significantly higher than the mean of 2.39 from 1982. The mean number of taxa by station, collected from the artificial and natural substrates during 1981, was 17.9 (SE +/-1.2) and 17.4 (SE +/-2.05 respectively, and 19.2 (SE +/-2.2) and 14.6 (SE +/-1.1), respectively, for 1982. Biotic index values derived from artificial substrates provided a more consistent and accurate description of the water quality of a small stream between years of high and low discharge than did those determined from natural substrates. Increased colonization of many invertebrates on artificial substrates coincided with high flows, whereas higher densities of several benthic invertebrate species occurred during low flows. Biotic index values based on artificial substrates more accurately represented the differences in the water quality of the creek relative to invertebrate response to organic nutrient levels, among years than did values derived from natural substrates. (White-Reimer-PTT)
W90-08697

DIATOMS AS INDICATORS OF WATER QUALITY IN SOME ENGLISH URBAN LAKES.
Oxford Univ. (England). Geography School.
M. A. J. Guzkowska, and F. Gasse.
Freshwater Biology FWBLAB, Vol. 23, No. 2, p 233-250, April 1990. 6 fig, 3 tab, 45 ref, 2 append.

Descriptors: *Bioindicators, *Diatoms, *England, *Lakes, *Urbanization, *Water chemistry, *Water quality, Conductivity, Hardness, Hydrogen ion concentration, Nitrates, Phosphates, Species diversity, Statistical analysis, Urban areas.

Diatom communities from a series of linked urban lakes in England are described in relation to water chemistry. Multivariate statistical techniques are used to show how indicator groups can be defined. Diatoms are classified into ecological groups using two-way species indicator analysis (TWINSPAN). Each ecological group is associated with a specific range of water-quality conditions. The headwater stream environments are differentiated from the lake habitats at level 1. At level 2 of TWINSPAN, the sampling sites are grouped into five ecological groups, according to their water chemistry and irrespective of the time of year. Detrended correspondence analysis (DCA) and principal components analysis (PCA) provide two statistically independent methods of assessing the environmental gradients along which the ecological groups are distributed. The most important physico-chemical parameters are total hardness, specific conductance and pH, followed by phosphates and nitrates. Eco-

logical groups I-V correspond to an environmental gradient ranging from the forested headwaters, which are acidic, of low specific conductance, total hardness and nutrient content, through the urban lakes, which are alkaline and of relatively high total hardness, specific conductance and nutrient content. Twelve site groups are identified at level 3 of TWINSPAN, each of which corresponds to a narrower range of water-quality conditions within the ecological groupings. A specific diatom assemblage is associated with each site group. The significance is that the diatom assemblage (or site group) was associated with the detailed topography of the individual sites. (See also W90-08701) (Author's abstract)
W90-08700

SEASONAL RESPONSE OF DIATOM COMMUNITIES TO VARIABLE WATER QUALITY IN SOME ENGLISH URBAN LAKES.
Oxford Univ. (England). Geography School.
M. A. J. Guzkowska, and F. Gasse.
Freshwater Biology FWBLAB, Vol. 23, No. 2, p 251-264, April 1990. 7 fig, 6 tab, 5 ref.

Descriptors: *Bioindicators, *Diatoms, *England, *Urbanization, *Water pollution effects, Species diversity, Statistical analysis, Storms, Urban areas, Urban runoff.

Five diatom assemblages and their corresponding site groups were associated with urban lakes in Bracknell New Town, England. When treated as a single dataset, detrended correspondence (DCA) and principal components analysis (PCA) grouped these diatom assemblages along an environmental gradient from circumneutral, dilute waters to strongly alkaline, concentrated, nutrient-rich waters. When treated as individual datasets, 75% of the known variance was explained by the first axis of DCA in all five diatom assemblages; this indicated the existence of a strong primary environmental gradient. The PCA results showed that the identity of this primary environmental gradient can be different for each assemblage. The statistical analyses showed that the physico-chemical gradients were continuous and not discrete. Nevertheless, fine-scale analysis can identify smaller, more precise species and site groups. Two types of species response could be identified within most subassemblages in the urban lakes: the first was a quasi-seasonal response and was characterized by a gradual rise to a peak relative abundance of one dominant or several co-dominant species which could be sustained for a period of weeks before a gradual decline. A quasi-seasonal response was sometimes interrupted by a storm response. The storm response was characterized by a sudden increase in the relative abundance of one or more diatom species following a storm, after which the species declined to pre-storm abundances within 7 days. The effects of urban runoff on the water quality of urban lakes can override the effects of true seasonal factors such as water temperature and day length on the relative abundance of species. (See also W90-08700) (Author's abstract)
W90-08701

MYTILUS EDULIS SHELL AS A BIOINDICATOR OF LEAD POLLUTION: CONSIDERATIONS ON BIOAVAILABILITY AND VARIABILITY.
Trent Univ., Peterborough (Ontario). Environmental and Resource Studies Program.
B. P. Bourgoin.
Marine Ecology Progress Series MESEDT, Vol. 61, No. 3, p 253-262, 1990. 5 fig, 2 tab, 47 ref.

Descriptors: *Bioindicators, *Lead, *Monitoring, *Mussels, Biological magnification, Mollusks, Pollutant identification, Tissue analysis.

The nacre of Mytilus edulis is suggested as an alternative to soft tissues for trace metal analyses in biological monitoring programs. The inner nacreous shell and soft tissues of mussels collected near a Pb smelter were analyzed for Pb and compared with the total-Pb content in suspended particulate matter (SPM). The results indicate that shells can provide an index of Pb bioavailability as the nacre-Pb levels were strongly correlated (p<0.001) with

the tissue-Pb concentrations. Although nacre sequesters about one tenth of the Pb measured in the tissues, the statistical variability associated with nacre-Pb levels is half that calculated for the tissues. Consequently, nacre-Pb levels offer a comparatively better relationship with the SPM Pb-content and also provide a significantly better spatial resolution. Other biophysical parameters such as mussel age, size, and littoral zonation may also affect mussel Pb concentrations. (Author's abstract)
W90-08719

FRESHWATER MUSSEL, WESTRALUNIO CARTERI IREDALE, AS A BIOLOGICAL MONITOR OF ORGANOCHLORINE PESTICIDES.
Western Australia Univ., Nedlands. Aquatic Research Lab.
A. W. Storey, and H. D. Edward.
Australian Journal of Marine and Freshwater Research AJMFA4, Vol. 40, No. 6, p 587-593, 1989. 2 fig, 1 tab, 14 ref.

Descriptors: *Bioaccumulation, *Bioindicators, *Halogenated pesticides, *Mollusks, *Monitoring, *Pesticides, DDD, DDE, DDT, Dieldrin, Lipid metabolism.

The freshwater mussel, Westralunio carteri, was tested as a biomonitor of the organochlorine pesticides dieldrin, DDE, DDD and DDT. The mussel survived handling, transportation and being caged, and demonstrated significant bioaccumulation of the pesticides. Total DDT analogues at one site reached a maximum of 0.48 mg/kg wet whole tissue after 112 days and at a second site accumulated to 1.23 mg/kg wet whole tissue after 66 days. The observed reductions in levels of bioaccumulated residues by activating mussels in an intermittent stream may be the result of preferential utilization of stored lipids and release of associated pesticides. (Author's abstract)
W90-08725

DETERMINATION OF PALLADIUM AND PLATINUM IN SEAWEED.
Korea Ocean Research and Development Inst., Seoul (Republic of Korea). Polar Research Div.
J. S. Yang.
Journal of the Oceanographical Society of Japan NKGKB4, Vol 45, No. 6, p 369-374, December 1989. 2 fig, 2 tab, 6 ref. NSF Grant No. OCE85-13486.

Descriptors: *Algae, *Atomic absorption spectrometry, *Bioaccumulation, *Bioindicators, *Fate of pollutants, *Palladium, *Platinum, *Pollutant identification, Algal physiology, California, Pacific Ocean.

Palladium and platinum concentrations were determined for twenty-two species of seaweed from the Californian coast. A new sensitive analytical technique using atomic absorption spectrometry was developed for palladium in seaweed. For the first time, palladium contents in seaweed were obtained. The contents of palladium and platinum varied from 0.09 to 0.061 ng/g and 0.25 to 1.75 ng/g in dried material, respectively. The average ratio of platinum to palladium found in seaweed was 3.5, while the ratio of platinum to palladium was 4.5 in seawater. Therefore, these species of seaweed do not selectively accumulate palladium and platinum from the ambient seawater, possibly because of the chemical similarity of the metals. (Author's abstract)
W90-08738

AIR POLLUTION IN THE WIND RIVER MOUNTAIN WILDERNESS: A LONG-TERM MONITORING PROGRAM OF THE FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE.
Bridger-Teton National Forest, Jackson, WY.
For primary bibliographic entry see Field 5C.
W90-08835

Group 5A—Identification Of Pollutants

SETTLING AND COAGULATION CHARACTERISTICS OF FLUORESCENT PARTICLES DETERMINED BY FLOW CYTOMETRY AND FLUOROMETRY.
Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.
K. A. Newman, F. M. M. Morel, and K. D. Stolzenbach.
Environmental Science and Technology ESTHAG, Vol. 24, No. 4, p 506-513, April 1990. 7 fig, 3 tab, 21 ref. NOAA Grant NA84-D-00046 and ONR Grants N00014-83-K-0661 and N00014-84-C-027.

Descriptors: *Coagulation, *Pollutant identification, *Sedimentation, *Tracers, Flow cytometry, Fluorescence, Fluorometry.

A new technique for detecting particles in natural waters relies upon the analysis of fluorescent emission by flow cytometry. Fluorescent pigment particles ranging in radius from less than 0.1 to 5 micrometer are available in sufficient quantity to be used as model particles. Laboratory coagulation and settling experiments analyzed by flow cytometry demonstrate that the efficiency with which the pigment particles coagulate with sewage particles is very low (less than 0.0005). Hence, in field applications these particles provide the limiting case of low-interaction behavior relative to natural particles. Removal from laboratory columns occurs primarily by noninteractive settling while thermal convection currents maintain nearly uniform particle concentration within the columns. Observed decreases in particle are number exponential (first order) for each size class as predicted for settling from well-mixed suspensions. The decrease in total suspended particle mass is higher order as a result of the difference in settling rates among particles. Thus, a system in which noninteractive settling dominates mimics systems in which coagulation processes are important. Flow cytometric analysis of particles removed by noninteractive settling shows the fluorescent emission from individual particles to be proportional to the particle surface area. These results enable flow cytometry to be used to detect, count, and size large numbers of particles rapidly. (See also W90-08943) (Author's abstract)
W90-08942

FLOW CYTOMETRIC DETECTION AND SIZING OF FLUORESCENT PARTICLES DEPOSITED AT A SEWAGE OUTFALL SITE.
Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.
K. A. Newman, S. L. Frankel, and K. D. Stolzenbach.
Environmental Science and Technology ESTHAG, Vol. 24, No. 4, p 513-519, April 1990. 4 fig, 3 tab, 13 ref. EPA Grant CR-81181-01-01, NOAA Grant NA84AA-D-00046, and ONR Grants N00014-83-K-0661 and N00014-84-C-027.

Descriptors: *Coagulation, *Particulate matter, *Path of pollutants, *Pollutant identification, *Tracers, Estuaries, Flow cytometry, Fluorescence, Massachusetts, Salem Sound, Sediments, Water movement.

A suspension of fluorescent pigment particles (total mass 120 kg) was injected over a period of several hours into a sewage outfall discharging into Salem Sound, MA. Flow cytometric analysis was used successfully to identify, quantify, and size the fluorescent pigment particles in bottom sediment and sediment trap samples collected 1-8 days after their release. Typical areal concentrations after 8 days were 1000 microgram/sq m (or roughly 100 ppb in the top 0.5 cm of sediment cores) corresponding to approximate 7% of the total released. The size distribution and recovered pigment particles were identical with the size distribution in the initial suspension, indicating that, despite their exceptionally low coagulation efficiency, net deposition of the pigment particles is affected by coagulation with other solids either in the water column or at the sediment-water interface. (See also W90-089242) (Author's abstract)
W90-08943

HEXAGENIA MAYFLIES: BIOLOGICAL MONITORS OF WATER QUALITY IN THE UPPER MISSISSIPPI RIVER.
Winona State Univ., MN. Dept. of Biology.
C. R. Fremling.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 139-143, Fall 1989. 3 fig, 39 ref.

Descriptors: *Aquatic insects, *Bioindicators, *Mayflies, *Minnesota, *Mississippi River, *Water quality, Sediment-water interfaces, Water pollution control, Water pollution effects.

Analysis of Hexagenia mayfly distribution patterns has proven to be a simple, inexpensive method of monitoring water quality in the Upper Mississippi River. Burrowing Hexagenia nymphs live at the mud-water interface intimately associated with the organically enriched sediments that have a strong affinity for contaminants. By their presence or absence in silted habitats, they assess the synergistic effects of hypoxia, toxins, and other stresses throughout the year. Adults are large and easily collected, providing inexpensive water quality monitoring on a river so large that comprehensive chemical, physical, and biological analyses are not logistically feasible or affordable. Pollution abatement in metropolitan Minneapolis-St. Paul allowed a recurrence of Hexagenia in formerly denuded areas of Pool 2 and Lake Pepin during the early 1980s, but the drought of 1988 caused a population crash in both areas, demonstrating that the environment at the mud-water interface was intolerable to Hexagenia during low flow conditions. (Author's abstract)
W90-08991

RADON-222 IN DRINKING WATER: AN NJDEP-EERF COLLABORATIVE STUDY.
New Jersey Dept. of Environmental Protection, Trenton. Div. of Environmental Quality.
B. Parsa, and T. Horton.
Health Physics HLTPAO, Vol. 58, No. 2, p 209-212, February 1990. 2 fig, 2 tab, 4 ref.

Descriptors: *Drinking water, *Interagency cooperation, *Laboratory methods, *New Jersey, *Pollutant identification, *Radon radioisotopes, Analytical methods, Calibrations, Comparison studies, Least squares method, Precision, Regression analysis, Water quality, Water sampling.

In order to demonstrate inter-laboratory precision in the Prichard and Gesell method for measuring radon-222 in water, a 2-year collaborative study was conducted by the New Jersey State Department of Environmental Protection (NJDEP) and the USEPA Eastern Environmental Radiation Facility (EERF). The majority of water samples were collected in duplicate from households located in the Reading Prong area of New Jersey. In both laboratories, results of liquid scintillation counting revealed radon-222 concentrations in water samples in the range from about 37 to 7400 Bq/L (1000 to 200,000 pCi/L). Least-squares linear regression analysis showed a very high correlation between the two sets of data. After taking into account uncertainties due to sample counting error and errors associated with the conversion factors of both laboratories, all the paired values of the two sets of measurements were within 2 standard deviations of each other. This close agreement demonstrates between-laboratory precision of this procedure when used to determine Radon-222 in drinking water. (Creskoff-PTT)
W90-09055

COPRECIPITATION OF TRACE METALS BY DNA AND RNA MOLECULES.
Hiroshima Univ. (Japan). Faculty of Integrated Arts and Sciences.
K. Fujiwara, R. Kojyo, and K. Okada.
Analytical Chemistry ANCHAM, Vol. 62, No. 5, p 504-508, March 1990. 5 fig, 2 tab, 23 ref.

Descriptors: *Chemical analysis, *Chemical precipitation, *DNA, *Nucleic acids, *Pollutant identification, *Sample preparation, *Trace metals, *Water analysis, Coprecipitation, Hydrogen ion concentration, Metal complexes, Natural waters, Separation techniques, Sodium chloride.

Coprecipitation of trace metal ions in aqueous samples was investigated using several nucleic acids (DNA and RNA) as carriers. After the pH of the solution containing metal ion was adjusted, DNA or RNA dissolved in NaOH solution was added. Precipitation of DNA (or RNA) was by the salting-out method, adding sodium chloride and acetone to the DNA-metal solution. Coprecipitation efficiencies for most positive metal ions were found to be maximum at pH 2-3 when sodium hydroxide-acetate buffer was used. Negative ions such as Cr2O2(--), Mo7O24(6-), and PtCl5(--) were not precipitated with DNA in the pH range from 1 to 12. It was found that coprecipitations of Co(III) complexes were dominated by their charge, i.e., the complexes having plus three charge are coprecipitated with DNA at the high rate but the complexes of zero or minus charge are not. The present coprecipitation method also allows the preconcentration of trace metal ions except iron, calcium, and magnesium, which were intrinsically contained in DNA and RNA at the appreciable concentration. (Author's abstract)
W90-09113

METHOD FOR THE EXTRACTION OF CARBONACEOUS PARTICLES FROM LAKE SEDIMENT.
University Coll., London (England). Palaeoecology Research Unit.
N. L. Rose.
Journal of Paleolimnology JOUPE8, Vol. 3, No. 1, p 45-53, 1990. 3 fig, 1 tab, 18 ref.

Descriptors: *Acid rain, *Carbon, *Lake sediments, *Particulate matter, *Pollutant identification, *Separation techniques, *Water pollution sources, Chemical analysis, Diatoms, Path of pollutants, Sedimentology.

A sensitive technique, based on particle concentrations, was developed that is suitable for the extraction of low amounts of carbonaceous particles from lake sediment. A previously reported technique, the Renberg and Wik method, due to the amount of residue left at the end of the digestion, is insensitive at low particle concentrations, and counting at times 50 will miss particles in the <10 micron fraction. The method used by Griffin and Goldberg deals with all charcoal, not just spherical particles produced from high temperature combustion, and so the results are expressed in per cent carbon by weight, rather than particle concentration. The present method reduces 10 g of dried Lake Michigan sediment to 10-30 mg of some of the more persistent minerals, primarily pyrite, anatase and rutile and zircon, but most importantly elemental carbon. It involves a more complete digestion than that of Renberg and Wik, and reduces the risk of fragmentation. The new method modifies the method of Griffin and Goldberg by changing the hydrofluoric acid step from 6 days at room temperature to 3 hr at 150 C. This change had no effect on the particles and almost halved the length of the digestion to 6 or 7 days. The new method was applied to a sediment core taken from Loch Tinker in Western Scotland, which had previously been analyzed using the Renberg and Wik method. Although the basic trends for both methods were the same, the new method was more sensitive to low particle numbers and more accurate, due to a more efficient extraction and a higher magnification for microscope counting. (Geiger-PTT)
W90-09126

INVESTIGATION OF COPPER COMPLEXATION IN THE SEVERN ESTUARY USING DIFFERENTIAL PULSE CATHODIC STRIPPING VOLTAMMETRY.
Water Research Centre, Medmenham (England).
For primary bibliographic entry see Field 5B.
W90-09128

STUDY OF ACID MINE DRAINAGE USING EARTH RESISTIVITY MEASUREMENTS.
Indiana Univ. at Bloomington. Dept. of Geography.
For primary bibliographic entry see Field 5B.

W90-09136

COMPARISONS OF THREE DIFFERENT ENRICHMENT TECHNIQUES IN THE DETERMINATION OF LEAD IN TAP WATER AND BOTTLED WATER BY FLAME ATOMIC ABSORPTION SPECTROMETRY.

Technical Univ. of Istanbul (Turkey). Dept. of Chemistry.
U. Koklu, and S. Akman.
Analytical Letters ANALBP, Vol. 23, No. 3, p 569-576, March 1990. 2 tab, 9 ref.

Descriptors: *Atomic absorption spectrophotometry, *Chemical analysis, *Flame photometry, *Lead, *Water analysis, *Water sampling, Bottled water, Comparison studies, Sample preparation, Tap water.

Lead contents of tap water and bottled spring waters were determined by flame-atomic absorption spectrometry. Because of the low concentration of lead, direct aspiration of samples into the flame was not suitable, so a preconcentration stage was necessary. The lead in water samples was concentrated by various methods. 'Evaporation,' 'extraction' and 'extraction after evaporation' of samples was used and their advantages and disadvantages were compared. The major disadvantages of evaporation are slowness and the concentrated matrix constituents, which increase the viscosity of the solution, thus reducing the uptake rate and altering the nebulizer efficiency. In this case, an analyte addition method is necessary. The most important advantages of extraction are that unwanted bulk matrix components are often not extracted, and that when aspirating an organic solvent into the flame, an increase in nebulization efficiency is observed. The sensitivity may increase compared with an aqueous solution. Extraction seems to be more rapid than evaporation. A third alternative, a combination of extraction with evaporation, was attempted to combine the advantages of both procedures. The disadvantage of evaporation, due to the concentration matrix, was eliminated by separation using the extraction procedure. (Chonka-PTT)
W90-09201

ENVIRONMENTAL SAMPLING: A SUMMARY.

Radian Corp., Austin, TX.
L. H. Keith.
Environmental Science and Technology ESTHAG, Vol. 24, No. 5, p 610-617, May 1990. 2 fig, 20 ref.

Descriptors: *Analytical techniques, *Baseline studies, *Data acquisition, *Data quality control, *Sample preservation, *Sampling, *Water sampling, Biological samples, Quality control.

Sample contamination is a common source of error and may come from artifacts in sampling containers or may be introduced during sample collection, preservation, handling, storage, or transport to the laboratory. Two basic sampling decisions that must be resolved during the planning stage and documented in the sampling protocol are the types and numbers of quality control samples to be taken. Careful documentation during preparation of the sampling plan will help eliminate misunderstandings later in the sampling effort. This documentation should include the objectives of the sampling; descriptions of the location, timing, and character of the samples to be taken; preservation precautions; sample identification; chain-of-custody records; and an indication of the analyses that are to be made. The most common transport mechanism for environmental pollutants are wind, rain, surface water, groundwater, and human intervention. Collection of samples must not significantly disturb the environment being sampled or the site will be changed and the analytical results will be biased. Contamination by sampling devices and materials can contribute relatively large errors in comparison to analytical procedures, especially when the analytes of interest are at low concentrations. The two parameters used most often to assess measurement quality objectives are bias and precision. Bias is a systematic deviation in data.

Precision is random variation in data. There are basically two types of controls: those used to determine whether an analytical procedure is in statistical control, and those used to determine whether an analyte of interest is present in a population under study, but not in a similar control population. (Chonka-PTT)
W90-09215

PHOTODISSOCIATION/GAS DIFFUSION/ION CHROMATOGRAPHY SYSTEM FOR DETERMINATION OF TOTAL AND LABILE CYANIDE IN WATERS.

Dionex Corp., Sunnyvale, CA.
Y. Liu, R. D. Rocklin, R. J. Joyce, and M. J. Doyle.
Analytical Chemistry ANCHAM, Vol. 62, No. 7, p 766-770, April 1990. 4 fig, 3 tab, 16 ref.

Descriptors: *Analytical methods, *Chemical analysis, *Cyanide, *Pollutant identification, *Water analysis, Detection limits, Ion exchange chromatography, Metal complexes, Photolysis, Quantitative analysis, Wastewater analysis.

The determination of concentrations of cyanide is very important for many environmental and industrial applications. An automated system was developed for determination of total and labile cyanide in water samples. The stable metal-cyanide complexes such as $Fe(CN)6(-3)$ are photodissociated in an acidic medium with an on-line Pyrex glass reaction coil irradiated by an intense Hg lamp. The released cyanide (HCN) is separated from most interferences in the sample matrix and is collected in a dilute NaOH solution by gas diffusion using a hydrophobic porous membrane separator. The cyanide ion is then separated from remaining interferences such as sulfide by ion exchange chromatography and is detected by an amperometric detector. The characteristics of the automated system were studied with solutions of free cyanide and metal-cyanide complexes. The results of cyanide determination for a number of wastewater samples obtained with the new method were generally in agreement with those obtained with the standard method. The sample throughput of the system is eight samples per hour and the detection limit for total cyanide is 0.1 microg/L. (Author's abstract)
W90-09263

UTILISATION OF LIQUID CHROMATOGRAPHY IN AQUATIC PHOTODEGRADATION STUDIES OF PESTICIDES: A COMPARISON BETWEEN DISTILLED WATER AND SEAWATER.

Instituto de Quimica Bio-Organica, Barcelona (Spain). Dept. of Environmental Chemistry.
G. Durand, D. Barcelo, J. Albaiges, and M. Mansour.
Chromatographia CHRGB7, Vol. 29, No. 3/4, p 120-124, February 1990. 5 fig, 29 ref.

Descriptors: *Analytical methods, *Atrazine, *Chemical analysis, *Diuron, *Fate of pollutants, *Liquid chromatography, *Mass spectrometry, *Pesticides, *Photolysis, *Water analysis, Comparison studies, Distilled water, Fenitrothion, Hydrolysis, Seawater.

The advantages of liquid chromatography with diode array and mass spectrometric detection are described for the direct characterization of the photodegradation products of Fenitrothion, Atrazine, and Diuron in distilled water and in artificial seawater samples. The photodegradation (UV wavelength >290 nm) of the herbicides Atrazine and Diuron was examined in distilled water and in artificial seawater containing humic acids. Major photodegradation products were hydroxyatrazine and Monuron, respectively. The results showed a faster degradation in seawater as compared to distilled water for Atrazine, whereas for Diuron a quenching effect of seawater on photodegradation was observed. The photodegradation of Fenitrothion was also investigated. For this pesticide, photodegradation in distilled water was very slow, necessitating the addition of acetone as a photosensitizer. In seawater, which has a higher pH, hydrolysis of Fenitrothion probably occurred. (Author's abstract)

W90-09269

SIMPLE FIELD TEST FOR THE DETECTION OF MERCURY IN POLLUTED WATER, AIR AND SOIL SAMPLES.

Ravishankar Univ., Raipur (India). Dept. of Chemistry.
L. Cherian, and V. K. Gupta.
Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 336, No. 5, p 400-402, March 1990. 1 tab, 12 ref.

Descriptors: *Analytical methods, *Field tests, *Mercury, *Pollutant identification, Air pollution, Colorimetry, Detection limits, Soil contamination, Water pollution.

A simple field test for the detection of mercury is described. The test is based on the ligand exchange reaction in which hexacyanoferrate(III) exchanges its cyanide ions with the chromogenic organic ligand succinyl dihydroxamic acid (SDHA). In the reaction, the colorless SDHA reacts with yellow K3Fe(CN)6 to give a greenish blue colored complex in a slightly acidic solution containing mercury. The reaction has been successfully applied for the detection of mercury in polluted water, air and soil samples. In air, at a velocity of about 0.2 L/min of the impinging air and a reaction temperature of 70 C, mercury(II) as low as 0.01 microg could easily be detected after 3 min exposure. In water, the limit of detection and limit of dilution were found to be 0.2 microg mercury(II) and 1:200,000. (Author's abstract)
W90-09272

USE OF CLADOPHORA GLOMERATA TO MONITOR HEAVY METALS IN RIVERS.

Durham Univ. (England). Dept. of Biological Sciences.
For primary bibliographic entry see Field 7B.
W90-09275

RESPONSE OF ANABAENA DOLIOLUM TO BIMETALLIC COMBINATIONS OF CU, NI AND FE WITH SPECIAL REFERENCE TO SEQUENTIAL ADDITION.

Banaras Hindu Univ., Varanasi (India). Centre for Advanced Study in Botany.
For primary bibliographic entry see Field 5C.
W90-09276

POLLUTION EFFECTS ON THE STRUCTURE OF MEIOFAUNAL COMMUNITIES IN THE BAY OF NAPLES.

Naples Univ. (Italy). Dipt. Genetica, Biologia Generale e Molecolare.
R. Sandulli, and M. de Nicola-Giudici.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 3, p 144-153, 1990. 17 fig, 3 tab, 31 ref.

Descriptors: *Bay of Naples, *Bioindicators, *Copepods, *Italy, *Pollutant identification, *Water pollution effects, Benthic fauna, Chemical properties, Chlorophyll a, Conductivity, Environmental effects, Eutrophication, Physical properties, Sediments, Water temperature.

High sensitivity, rapid turnover rate, quick response, life cycles entirely spent in sediments and relative population stability, are the main characteristics that make meiofauna a valid means to assess the impact of environmental stress. A 13 month field investigation on the status of meiofaunal communities was carried out in an area of the Bay of Naples, Italy affected by urban pollution. Four subtidal sites having different hydrodynamic regimes but similar depth and sediment granulometry allowing interstitial fauna existence were investigated. Sediment samples were collected by scuba divers. Physico-chemical parameters, including water temperature, sediment redox potential, particulate organic carbon, and chlorophyll a, were also monitored. The data were subjected to multivariate analysis, and from the results it was possible to detect a stress gradient in the four sites under study due to their differences in the environmental characteristics. The harpacticoid copepods

are differentially influenced by organic enrichment. The mesobenthic species suffer heavily in eutrophicated situations; while many non-interstitial harpacticoid species are very tolerant and may reach very high abundance in organically enriched areas. In particular, Bulbamphiascus imus, an opportunistic species, always represent the vast majority of the species present in the area, in some cases it is the only species. It is concluded that meiofauna, and in particular the harpacticoid copepod assemblage, might be considered a very sensitive and useful tool in pollution monitoring studies. (Mertz-PTT)
W90-09300

DISTRIBUTION AND SOURCES OF ALIPHATIC HYDROCARBONS IN FISH FROM THE ARABIAN GULF.
Basrah Univ. (Iraq). Marine Science Centre.
H. T. Al-Saad.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 3, p 155-157, 1990. 2 fig, 2 tab, 7 ref.

Descriptors: *Arabian Gulf, *Bioindicators, *Fish, *Hydrocarbons, *Oil pollution, *Pollutant identification, Marine fisheries, Petroleum hydrocarbons, Water pollution, Water pollution sources.

A major fraction of petroleum consists of aliphatic hydrocarbons which may be used to detect its presence in the environment. An important route is the uptake and assimilation of these components by marine organisms in general and fish in particular. Thirteen fish species were collected during 1985 from Arabian Gulf waters. The edible tissues were extracted. N-alkanes were analyzed by gas chromatography. The concentration of n-alkanes in the Arabian Gulf fish varied from 6.4 microgram/g to 32.6 microgram/g. Variations in hydrocarbon content of different fish species from the same location may be attributed to feeding pattern, type of habitat and fat content. The range of carbon chain length of n-alkanes for the Arabian Gulf fish are C10-C32. The bimodal distribution with two maxima around C17 and C27 suggest two different sources of hydrocarbons both biogenic and anthropogenic. This study shows the presence of even-carbon numbered n-alkanes, which may be related to a contribution from artificial sources. The presence of squalane, a major organic constituent in polluted waters, was intimately correlated with anthropogenic sources of hydrocarbons. This compound was encountered in all fish sampled and may indicate the polluted nature of the region. Monitoring of hydrocarbons in commercial fish from the Arabian Gulf is recommended. (Mertz-PTT)
W90-09302

METHOD TO EVALUATE THE VERTICAL DISTRIBUTION OF VOCS IN GROUND WATER IN A SINGLE BOREHOLE.
Lawrence Livermore National Lab., CA. Environmental Restoration Div.
F. Hoffman, and M. D. Dresen.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 2, p 95-100, Spring 1990. 5 fig, 8 ref.

Descriptors: *Boreholes, *Groundwater pollution, *Path of pollutants, *Sampling, *Volatile organic compounds, *Water sampling, Cores, Drilling, Horizontal distribution, Vertical distribution.

Volatile organic compounds (VOCs) are present in multiple water-bearing zones beneath and downgradient of Lawrence Livermore National Laboratory. This area is composed of interfingering unconsolidated alluvial sediment with hydraulic conductivities ranging over four orders of magnitude. The more permeable sediments exhibit moderate hydraulic interconnection horizontally and less interconnection vertically, and appear to consist largely of interconnected stream channel deposits. To optimize selection of monitoring well screened intervals in this complex environment, a technique that enables collection of saturated formation samples from each water-bearing zone without contamination from other VOC-containing zones was developed, tested, and implemented. The technique utilizes a wireline punch-coring system that allows the drill bit to be replaced with a core

barrel without removing the drill rod from the borehole. To help ensure that a sample from one water-bearing zone is not contaminated by VOCs from another zone, the drilling fluid is replaced with new fluid before each sampling run. Overnight chemical analysis by gas chromatography enables field personnel to know the vertical distribution of VOCs as drilling proceeds. Since its first use in 1985, the technique has successfully characterized the presence or absence of VOCs in groundwater in 123 of 140 wells, many with concentrations in groundwater in the low parts-per-billion range. The sampling technique is a cost-effective and rapid method of evaluating the vertical distribution of VOCs in groundwater in a complex hydrogeologic environment. (Author's abstract)
W90-09312

DIFFERENTIATION OF THE ORIGINS OF BTX IN GROUND WATER USING MULTIVARIATE PLOTS.
National Water Research Inst., Burlington (Ontario). Groundwater Contamination Section.
S. Lesage, and P. A. Lapcevic.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 2, p 102-105, Spring 1990. 6 fig, 10 ref.

Descriptors: *Data processing, *Groundwater pollution, *Hydrocarbons, *Multivariate analysis, *Statistical methods, *Water analysis, *Water pollution sources, Benzene, Boreholes, Computer programs, Computers, Graphical analysis, Injection wells, Oil pollution, Ontario, Path of pollutants, Toluene, Water sampling, Xylenes.

A 300 m multilevel borehole was installed near injection wells and water samples from various levels were analyzed for volatile organic compounds. The concern was that the injected wastes from the petrochemical industry in Sarnia, Ontario could potentially migrate upward and contaminate the shallow groundwater. Multivariate plots were utilized to create fingerprints of aromatic hydrocarbon residues in groundwater. The technique allows hydrogeologists to distinguish between residues of benzene, toluene, ethyl benzene, and total xylenes (termed collectively BTX) originating from groundwater contact with petroleum in natural deposits and refined petroleum waste products. Examples were taken from deep-well injection of refinery wastes, natural petroleum deposits, municipal and industrial landfill leachates, coal tar and creosote contaminated waters, and varnish industry contaminated groundwater. The data were plotted from ASCII files generated through either a spreadsheet or a database report program, using a simple Fortran interactive program with plotting subroutines. The contaminants to be plotted were selected on the basis of their general prevalence in petroleum products and as significant groundwater contaminants based on their solubility. The higher alkylated benzenes offered the best diagnostic value. The method proved useful in comparing residues of samples that were close to their respective source. As the distance of monitoring wells from the source increases, it is expected that these fingerprints would be altered slightly to reflect the mobility of the individual contaminants in groundwater. (White-Reimer-PTT)
W90-09313

DEVELOPMENT OF A STANDARD, PURE-COMPOUND BASE GASOLINE MIXTURE FOR USE AS A REFERENCE IN FIELD AND LABORATORY EXPERIMENTS.
Arizona State Univ., Tempe. Dept. of Civil Engineering.
D. K. Kreamer, and K. J. Stetzenbach.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 2, p 135-145, Spring 1990. 9 tab, 22 ref. EPA Cooperative Agreement 814701.

Descriptors: *Fuel, *Gasoline, *Oil pollution, *Path of pollutants, *Pollutant identification, *Underground storage tanks, *Water analysis, Chemical properties, Groundwater pollution, Standards, Storage tanks.

In recent years, leaking underground petroleum storage tanks have become a major environmental

concern. Because petroleum products are mixtures of many compounds and the composition frequently changes, there exists a need for a standard reference mixture that can be used as a basis for comparison in the study of fluid transport properties in porous media and to evaluate leak detection devices. A standard is proposed that retains the most important liquid and vapor properties (such as vapor density, air diffusion coefficient, and basic chemical constituency) of gasoline mixtures. It is impossible for one mixture of a surrogate gasoline to be representative of all gasolines or begin to address every conceivable laboratory or field test. Generally, a reference surrogate fuel is regarded as a base mixture, with enough flexibility in its application to allow the addition or removal of some compounds. The first approach is to choose approximately 10 of the major components of gasoline and add these to the mixture in approximately the same concentrations that they are found in automotive fuel. A second approach is to use compounds representative of the major classes of compounds found in gasoline such as aromatics, paraffins, and olefins. There is a need for different types of reference surrogate gasoline mixtures which encompass a range of normal automotive fuels. The three categories of high Reid vapor pressure, low Reid vapor pressure, and high octane fuel were chosen in an attempt to span this admittedly large range of available gasolines. It is believed that these main categories would produce a range of response by detection devices, particularly vapor detectors. These standards could be used in physical models and also in theoretical descriptions of the partitioning of the various components of gasoline. (White-Reimer-PTT)
W90-09315

ALGAL ASSAYS TO INTERPRET TOXICITY GUIDELINES FOR NATURAL WATERS.
Ontario Ministry of the Environment, Rexdale. Water Resources Branch.
S. L. Wong.
Journal of Environmental Science and Health (A) JESEDU, Vol. 24, No. 8, p 1001-1010, 1989. 3 fig, 2 tab, 16 ref.

Descriptors: *Algae, *Analytical methods, *Bioassay, *Copper, *Pollutant identification, *Toxicity, *Water quality standards, Daphnia, Plankton, Rainbow trout.

Algal assays were used to establish toxicity guidelines for natural waters. 'Cu equivalent' rather than the conventional EC50 value was used as the toxicity unit. By correlating Cu dosages with % of control growth, Cu reference curves were constructed for the test species, Chlorella, and Scenedesmus. These Cu curves, which compensated for species sensitivity differences, were then used to translate algal growth response to toxicity of the test waters. Expressed in Cu equivalent, the test waters displayed a toxicity range from 25 to 300 microg Cu/L. After further tests with Cu on organisms such as algae, Daphnia and rainbow trout, 'sensitive' water where delicate plankton species could not survive was found at Cu eq. concentrations between 90 and 120 microg/L. The toxicity guidelines for natural waters were then set at: (a) unacceptable--above 120 microg Cu/L; (b) sensitive--between 90 and 120 microg Cu/L; (c) acceptable--below 90 microg Cu/L; and (d) no harmful effect concentration--5 microg Cu/L according to the Great Lakes water quality criteria. (Author's abstract)
W90-09324

AUTOMATED PERMEATION SAMPLER FOR PHENOLIC POLLUTANTS.
Akron Univ., OH. Dept. of Chemistry.
G. Z. Zhang, and J. K. Hardy.
Journal of Environmental Science and Health (A) JESEDU, Vol. A24, No. 8, p 1011-1024, 1989. 4 fig, 3 tab, 11 ref.

Descriptors: *Analytical methods, *Automation, *Phenols, *Pollutant identification, *Samplers, Detection limits, Monitoring, Permeation, Sampling, Thermal desorption.

A method for the determination of phenolic pollutants in water using an automated permeation sampler was developed. The automated sampler combines permeation and thermal desorption techniques. Phenols permeating through a membrane are purged into a sampling tube containing Tenax-TA adsorbent. Samples collected are thermally desorbed onto a capillary column gas chromatograph. Phenolic concentrations as low as 10 ppb for several phenols can be achieved by this method. The automated permeation sampler provides an alternative way to monitor the concentration of phenolic pollutants. The sampling and analysis procedure is straight forward and requires minimal operator interaction. Several parameters can be modified to enhance the performance of the permeation sampler, such as increasing the membrane area, the sampling collection time and the suitable sampling temperature. An automatic pH adjusting device can also be employed for improving the automation process. Although this sampler was tested for a fixed concentration at a short sampling time, it can also be used to monitor the time-weighted average concentration at a longer sampling period for a variable phenolic concentration stream. (Author's abstract)
W90-09325

EXTRACTION AND CONCENTRATION OF NONPOLAR ORGANIC TOXICANTS FROM EFFLUENTS USING SOLID PHASE EXTRACTION.
Environmental Research Lab., Duluth, MN.
E. J. Durhan, M. T. Lukasewycz, and J. R. Amato.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 4, p 463-466, April 1990. 2 tab, 10 ref.

Descriptors: *Analytical methods, *Chemical analysis, *Pesticides, *Pollutant identification, *Wastewater analysis, Carbofuran, Chlorfenvinphos, Diazinon.

To control toxic pollutants in effluents, it is necessary first to identify the toxicants. To make identification possible it is desirable to isolate the toxicants from their effluent matrices and concentrate them. A simple method was developed in which the nonpolar organic fraction of an effluent is concentrated into methanol. The methanol solution can be directly analyzed by Gas Chromatography-Mass Spectroscopy (GC-MS) and can also be diluted and tested for toxicity. Synthetic-effluent spiking experiments were conducted using the pesticides diazinon, carbofuran, and chlorfenvinphos. Results from the laboratory where this method is being used show that in cases where the effluent toxicants were nonpolar organic compounds 60% of the effluent's toxicity was recovered in the methanol concentrate and the toxicants were identified by GC-MS. (Author's abstract)
W90-09337

CHEMICAL EQUILIBRIUM ANALYSIS OF LEAD AND BERYLLIUM SPECIATION IN HAZARDOUS WASTE INCINERATORS.
Kansas State Univ., Manhattan.
For primary bibliographic entry see Field 7B.
W90-09385

SPECIATION OF ALUMINUM IN GEOTHERMAL BRINES: COMPARISON OF DIFFERENT METHODOLOGIES.
CISE S.p.A., Technologie Innovative, Segrate (MI), Italy.
For primary bibliographic entry see Field 2K.
W90-09391

MONITORING ATMOSPHERIC DEPOSITION IN CALIFORNIA'S SIERRA NEVADA: A COMPARISON OF METHODS.
Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.
For primary bibliographic entry see Field 7B.
W90-09417

CHEMICAL COMPOSITION OF PRECIPITATION, DEW AND FROST, AND FOG IN DENVER, COLORADO.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-09418

DISTRIBUTION, CHEMICAL AND ISOTOPIC CHARACTERISTICS OF PRECIPITATION EVENTS IN AN ARID ENVIRONMENT - MAKHTESH RAMON BASIN, ISRAEL.
Hebrew Univ. of Jerusalem (Israel). Seagram Centre for Soil and Water Sciences.
For primary bibliographic entry see Field 5B.
W90-09419

COMPARISON OF IONIC COMPOSITION OF CLOUDWATER WITHIN AND ABOVE THE CANOPY OF AN ABOVE CLOUDBASE FOREST.
North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.
For primary bibliographic entry see Field 5B.
W90-09420

USE OF GRASS SHRIMP (PALAEMONETES PUGIO) LARVAE IN FIELD BIOASSAYS OF THE EFFECTS OF AGRICULTURAL RUNOFF INTO ESTUARIES.
Duke Univ., Beaufort, NC. Marine Lab.
W. W. Kirby-Smith, S. P. Thompson, and R. B. Forward.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 29-37, 2 fig, 2 tab, 2 ref. EPA Contract CR813415-01.

Descriptors: *Agricultural runoff, *Bioassay, *Estuarine environment, *Nonpoint pollution sources, *Pesticide residues, *Shrimp, *Water pollution effects, Biological studies, Carbamate pesticides, Ecotoxicology, Estuaries, Field tests, Growth, Larvae, Path of pollutants, Permethrins, Thiodicarb, Toxicity.

Investigations of the effects of runoff from pesticide-sprayed fields on survivorship of the larvae of the grass shrimp Palaemonetes pugio began in the summer of 1988. Gravid shrimp were held in cages in the surface waters of two estuarine creeks. One of the creeks received runoff from fields recently sprayed with the pesticides permethrin and thiodicarb, while the other creek received runoff from an unsprayed forested area. Larvae released from field exposed shrimp were reared in the laboratory in runoff water from the farm, in runoff water from forest drainage, and in control water. Permethrin was undetectable (< 1 ngper sample) in all water except one of the three replicates of farm runoff where traces (8 ng per sample) were found. Survivorship was high (75-94%) in all treatments except for larvae reared in farm runoff water, where survivorship was 27-35% which differed significantly from all other treatments.In a second experiment three weeks after pesticide application survivorship was 94-98% in all treatments. Data from pesticide residue analysis area complete only for permethrin. Data indicates that runoff from agricultural fields sprayed with pesticides applied in full accordance with labeled instructions can significantly reduce survivorship of larval grass shrimp, although at this time the cause of mortality is unknown. (See also W90-09440) (Author's abstract)
W90-09443

HERBICIDE MONITORING OF TILE DRAINAGE AND SHALLOW GROUNDWATER IN NORTHWESTERN OHIO FARM FIELDS--A CASE STUDY.
Science Applications International Corp., Denver, CO.
For primary bibliographic entry see Field 5B.
W90-09445

ASSESSMENT OF OCCURRENCE OF AGRICULTURAL CHEMICALS IN RURAL, PRIVATE WATER SUPPLIES.
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 7A.
W90-09447

SOS MICROTITRATION CHROMOTEST BIOASSAY FOR GENOTOXIC PESTICIDES.
Bowling Green State Univ., OH. Dept. of Biological Sciences.
H. Xu, and K. Schurr.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 121-126, 4 fig, 10 ref.

Descriptors: *Bioassay, *Bioindicators, *Pesticides, *Pollutant identification, *Toxicity, *Water pollution effects, Ames test, Biochemistry, Captan, Ecotoxicology, Folpet, Fungicides, Microtitration.

The SOS Microtitration Chromotest is a rapid, accurate bioassay appropriate to determine genotoxicity of industrial chemicals, food additives, drugs, pesticides and environmental hazards. Two substituted phthalimide fungicides, captan and folpet, were tested for genotoxicity by this method to determine the rates of decomposition under conditions likely in the natural environment. Under sunlight and heat radiation, captan decomposed rapidly, while folpet remained essentially unaffected. This procedure is recommended for the testing of synergy and for multiple pesticides in potable water samples. (See also W90-09440) (Lantz-PTT)
W90-09449

EVALUATION AND COMPARISON OF THE EXTRACTION PROCEDURE TOXICITY TEST (EP) AND TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR ANALYSIS OF PESTICIDES IN WASTE WATER SLUDGES.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Environmental Engineering.
S. A. Chesnutt, L. A. Alderman, D. L. Gallagher, and A. N. Dietrich.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 249-258, 4 tab, 11 ref.

Descriptors: *Bioassay, *Pesticides, *Pollutant identification, *Sludge, *Wastewater analysis, Bromoform, DDT, Ethylene dibromide, Fusarex, Heptachlor, Leaching, Municipal wastewater, Toxicity, Water quality control.

The Toxicity Characteristic Leaching Procedure (TCLP) and the Extraction Procedure Toxicity Test (EP) were evaluated for their ability to recover surrogate pesticide and organic chemical standards added to municipal wastewater sludges, and also to detect other unknown pesticides present or in sludge samples. The surrogate chemicals were 1,2-dibromoethane, fusarex, heptachlor, DDT, bromoform and 1-chlorooctane. Triplicate samples from three municipal wastewater treatment facilities that treated only domestic water and the land-applied the sludges, were investigated. The research indicated that both the TCLP and the EP tests had high within-test variability for recovery of the surrogate chemicals. Recovery of surrogate chemicals was low (0-33%) and extremely variable in both tests and from sludge to sludge. Attempts were made to correlate recoveries with physical/chemical parameters for the surrogate chemicals and sludge characteristics. No pesticides other than the added surrogates were identified in the sludges. (See also W90-09440) (Author's abstract)
W90-09460

USE OF SOLID-PHASE RESINS IN PESTICIDE MONITORING.
Richmond Univ., VA. Dept. of Biology.
J. A. Bittinger, and J. W. Bishop.
IN: Pesticides in Terrestrial and Aquatic Environ-

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5A—Identification Of Pollutants

ments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 265-269, 1 tab, 6 ref.

Descriptors: *Herbicides, *Ion exchange, *Monitoring, *Pesticides, *Pollutant identification, *Resins, Amberlite, Atrazine, Desorption, Extraction, Regression analysis, Statistical analysis, Water quality control.

The feasibility of using solid-phase resins for monitoring pesticide concentrations in water was examined. Relationships between concentrations of the herbicide atrazine and the resin amberlite XAD-2 were observed in the laboratory. Solutions of atrazine were passed through columns of the resin. Methylene chloride was used to extract atrazine from water and to desorb atrazine from the resin which was measured spectrophotometrically. Atrazine adsorption by the resin increased with increased concentrations of the herbicide. As atrazine concentrations rose in the water from 0.35 to 1.68 mg/L, the adsorption increased from 0.22 to 1.53 mg/L (Extraction Method), and from 0.23 to 2.26 mg/L (Desorption Method). Analysis of variance indicated that the regressions between concentrations of atrazine in the water and concentrations of atrazine adsorbed by the resin were statistically significant ($p < 0.05$). The adsorption efficiencies increased with the increased concentrations of atrazine in the water. They ranged from 62 to 95% (Extraction Method), and 56 to 184% (Desorption Method). The regression based on the Extraction Method was statistically significant (88.6%). The increased efficiencies at higher concentrations suggest that the atrazine may have induced adsorption somewhat akin to the 'induced-fit hypothesis' for enzyme kinetics. (See also W90-09440) (Lantz-PTT)
W90-09462

ENVIRONMENTAL MONITORING PROGRAMS OF THE U.S. FISH AND WILDLIFE SERVICE.
Fish and Wildlife Service, Washington, DC. Div. of Environmental Contaminants.
J. A. Andreasen.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 292-298, 3 fig, 2 tab.

Descriptors: *Environmental protection, *Fish and Wildlife Service, *Halogenated pesticides, *Monitoring, *Path of pollutants, *Pesticides, Biological studies, DDT, Institutions, Tissue analysis, Water quality control.

The National Contaminant Biomonitoring Program (NCBP) is the most extensive and longest running biomonitoring program in the nation whose purpose is to monitor pesticides in the environment. There are three complimentary tissue residue sampling networks maintained by the NCBP-whole fish tissue, whole body starlings, and duck wings. Fish tissues from 112 stations representing all major river basins in the continental U.S., Alaska and Hawaii, are analyzed for organochlorine pesticides, PCPs and metals on a two year cycle. Examination of data from the fish portion of the NCBP shows some major trends. There is a statistically significant decline in DDT, PCBs, and dieldrin, between 1976 and 1984 indicating that bans on the use of these chemicals has been effective in removing them from the ecosystem. The second part of the NCBP is the starling collection network. Ten whole birds are collected and tissue analyzed from 110 predetermined sites every three years. Data show that over all DDE residues have declined. Duck wings, the third part of the NCBP, are also analyzed on a three year rotation for the same suite of contaminants as the fish and starlings. Data from the NCBP show the pervasiveness and persistence of organochlorine chemical contaminants. For example, even though DDT was banned in the U.S. in 1972, residues derived from DDT were detected in fish from 98% of the stations sampled in 1984. An estuarine, fish eating bird species will be added to the network, and additional sites, contaminants and

bioassessment methods may be made part of the program, while duck wings and starling analysis may be dropped. (See also W90-09440) (Lantz-PTT)
W90-09464

TOXICITY OF SELECTED UNCOUPLING AND ACETYLCHOLINE ESTERASE-INHIBITING PESTICIDES TO THE FATHEAD MINNOW (PIMEPHALES PROMELAS).
Wisconsin Univ.-Superior. Center for Lake Superior Environmental Studies.
D. J. Call, S. H. Poirier, C. A. Lindberg, S. L. Harting, and T. P. Markee.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 317-336, 2 fig, 6 tab, 35 ref, EPA Cooperative Agreements CR809234 and CR811590.

Descriptors: *Acetylcholine esterase, *Bioassay, *Bioindicators, *Fathead minnows, *Organophosphorus pesticides, *Pesticides, *Toxicity, *Water pollution effects, Biological studies, Carbamate pesticides, Ecotoxicology, Environmental effects.

The toxicity of various pesticides to the fathead minnow (Pimephales promelas) following short and long-term exposure was studied. Pesticides were grouped into three categories: (1) uncouplers of oxidative phosphorylation, (2) organophosphate acetyl cholinesterase (AChE) inhibitors, and (3) carbamate AChE inhibitors. Exposures were conducted in flow-through systems with toxicant concentrations continuously renewed and regularly measured. The dilution water was a relatively soft, dechlorinated tap water with a pH of about 7.2. Acute toxicities of fourteen pesticides to juvenile fathead minnows (28-38 days old) were determined. The acute toxicity of the carbamates to fathead minnows was compared to their inhibition of AChE activity in rainbow trout (Onochorhynchus mykiss) brain tissue in vitro. A rather weak relationship was observed overall, with the most acutely toxic carbamate to fat head minnows, carbofuran, inhibiting AChE to the greatest extent and the least toxic carbamate, pirimicarb, inhibiting AChE the least. Acute-chronic ratios are larger and more variable for organophosphates and carbamates than for uncouplers. Larger factors would be required for estimating safe chronic exposure concentrations from acute data for organophosphates and carbamates. Acute and early life stage toxicity of phenolic uncouplers can be estimated from QSAR prediction made from QSAR prediction models based upon the property of lipid solubility. No prediction models are available at present for organophosphate and carbamate inhibitors of AChE activity. In vitro assays of AChE inhibition and toxicity do not correlate highly. Growth endpoints of length, net weight, and dry weight were the most sensitive in the majority of ELS tests. (See also W90-09440) (Lantz-PTT)
W90-09465

USE OF SOIL GAS INVESTIGATIONS TO DETECT GROUNDWATER AND SOIL CONTAMINATION.
Tracer Research Corp., Tucson, AZ.
K. L. Suess, and G. M. Thompson.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 55-61, 3 fig.

Descriptors: *Data acquisition, *Groundwater pollution, *Mapping, *Path of pollutants, *Pollutant identification, *Soil contamination, *Soil gases, *Volatile organic compounds, Aeration zone, Hydrocarbons, Solvents, Vadose water.

A rapid method of detecting and delineating the areal extent of groundwater and soil contamination by volatile organic chemicals (VOCs) traces VOCs in groundwater or soil via their presence in the shallow soil gas. The presence of VOCs in shallow soil gas indicates the observed compounds may either be in the vadose zone near the sampling probe or in the groundwater below the sampling

probe. This soil gas technology is most effective in mapping low molecular weight halogenated solvent chemicals and petroleum hydrocarbons possessing high vapor pressures and low aqueous solubilities. These compounds readily partition out of the groundwater and into the soil gas as a result of their high gas/liquid partitioning coefficients. Once in the soil gas, VOCs diffuse vertically and horizontally through the soil to the ground surface where they dissipate into the atmosphere. The subsurface contamination acts as a source and the above ground atmosphere acts as a sink, and typically a concentration gradient develops between the two. Two case studies are examined which give typical examples of plume mapping and source identification applications of soil gas technology. (See also W90-09479) (Author's abstract)
W90-09484

DETERMINATION OF FREE CYANIDE LEVELS IN SURFACE AND GROUND WATERS AFFECTED BY HIGHWAY SALT STORAGE FACILITIES IN MAINE.
Maine Dept. of Transportation, Augusta.
A. C. Olson, and T. Ohno.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 63-77, 6 fig, 4 tab, 7 ref.

Descriptors: *Cyanide, *Path of pollutants, *Pollutant identification, *Water pollution sources, Fate of pollutants, Highway effects, Maine, Sodium chloride, Soil contamination, Standards, Surface water.

To ensure uniform spreading, sodium ferrocyanide is often added to highway de-icing salt as an anti-caking agent. Although the toxicity of ferrocyanide is low, exposure to sunlight can photodecompose the complex cyanide into simple cyanide (CN-and HCN), which is highly toxic. Four highway facilities where sand and salt are mixed and stored in uncovered piles were investigated in 1988. Exceptionally high chloride values had been reported in nearby surface waters at each site. Surface water sampling sites were selected upstream, adjacent to, and downstream from the facilities; samples were collected on a monthly basis. A well drilled into bedrock was also monitored at one location. Water samples were irradiated and analyzed for total cyanide. At the pH range found in the sampled waters, most of the total cyanide would be in the form of simple cyanide. Elevated concentrations of sodium chloride (NaCl) and total cyanide were found in surface waters adjacent to all four facilities. Total cyanide levels exceeded guidelines set by the US EPA for the protection of wildlife (52 ppb CN-) and for drinking water (10 ppb CN-). The concentration of total cyanide in nearly all samples was below the detection limit of 10 ppb within 500 feet downstream from each site. No cyanide was detected in the well. The theoretical concentration of total cyanide for each sample was calculated using the CN-/Na ratio from a sample of pure road salt. At all sites the actual cyanide concentration was less than the predicted maximum concentration of cyanide. The lower than predicted levels of cyanide suggest that the cyanide is being adsorbed onto soil particles during overland flow, or is being adsorbed onto sediment in nearby bogs. (See also W90-09479) (Author's abstract)
W90-09485

ORGANIZATION AND OPERATION OF THE SAVANNAH RIVER PLANT'S GROUNDWATER MONITORING PROGRAM.
Du Pont de Nemours (E.I.) and Co., Pompton Lakes, NJ.
C. M. Olson, and J. D. Heffner.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 375-386, 5 fig.

Descriptors: *Groundwater quality, *Monitoring, *Network design, *Savannah River Plant, *Water

pollution control, *Water quality, Computers, Management planning, Water analysis, Water quality control, Water quality management, Water sampling.

There are two key features and three concepts that allow the Groundwater Monitoring Program (GMP) to handle an active drilling program and a quarterly data acquisition system (with reports--documentation) yet contain provisions for continued growth. Two key features allow the program to respond to deadlines: modular sections and computer usage. Each modular unit in the GMP has well-defined responsibilities, broad operational latitude and is staffed by qualified people. Extensive use of computers enables the GMP to collate and review a large amount of data, to report this information to the appropriate organizations and to generate a new sample schedule--all within strict time constraints. Both of these features, modular units and computer usage, are adaptable to allow for growth in the GMP--an important consideration in today's regulatory climate. Three concepts, consistency, flexibility and responsiveness allow a large program to be easily defined yet adaptable to a wide variety of conditions. It is consistent because the sampling schedule for all of the facilities is governed by the same basic set of rules (the sampling guide). It is flexible because the sampling guide is used to determine a basic level of suggested parameters for each sample schedule (alter the sample guide and the focus or direction of the entire Program can change). It is responsive because it incorporates two feedback loops. One loop uses past analytical results from a facility to determine if the facility's water quality changes; if so, so does the sample schedule. The second loop, also a review of analytical results, determines if the monitor well is in the appropriate location. These concepts: consistency, flexibility and responsiveness enable the GMP to comply with today's requirements, to adapt to future requirements and to accommodate to changes in the environment being monitored. The GMP at the Savannah River Plant is one of the largest groundwater monitoring programs in the country. Since the implementation of the Program in late 1986 it has successfully operated using the format outlined in this paper. During 1987, the Program has experienced a 30% growth, easily accommodating the increase in all Program activities as well as the accompanying regulatory scrutiny. (See also W90-09479) (Author's abstract)
W90-09506

5B. Sources Of Pollution

CONTAMINANTS IN FOODS OF AQUATIC BIRDS AT KESTERSON RESERVOIR, CALIFORNIA, 1985.
Patuxent Wildlife Research Center, Laurel, MD.
R. L. Hothem, and H. M. Ohlendorf.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 6, p 773-786, November 1989. 1 fig, 5 tab, 36 ref.

Descriptors: *Aquatic insects, *Aquatic plants, *Arsenic, *Boron, *Kesterson Reservoir, *Path of pollutants, *Selenium, *Water birds, *Water pollution effects, Bioaccumulation, California, Ecological effects, Food chains, Gambusia, Heavy metals, Volta Wildlife Area.

Plants, aquatic insects, and mosquitofish were collected from Kesterson Reservoir, Merced County, California, and a nearby reference site (Volta Wildlife Area) to compare concentrations of three contaminants found in 1985 with those reported in 1983 and 1984. Mean selenium concentrations in food-chain organisms from sites at Kesterson in 1985 ranged from 26.0 micrograms/g (dry weight) in water boatman (Corixidae) to 119 micrograms/g in mosquitofish. All mean selenium concentrations at Kesterson were significantly higher than those from Volta and were sufficient to have caused the impaired avian reproduction observed at Kesterson. Boron concentrations were also significantly higher at Kesterson, and, in one pond, the mean concentration in widgeongrass (1630 micrograms/g) was high enough to impair avian reproduction. There were no differences in arsenic concentrations between locations, and concentrations in all

food-chain organisms (< 1.9 micrograms/g) were lower than those reported to cause adverse effects in wildlife. Within-location differences were observed for all three contaminants at Kesterson and for selenium at Volta, but there was no consistent pattern to these differences. Between-year comparisons showed that selenium concentrations in mosquitofish generally decreased at Kesterson, but remained the same at Volta over the 3 years. Selenium concentrations in insects from 1985 were lower at Kesterson than in 1983, but were similar to 1984. Concentrations in plants were generally higher in 1983 and lower in 1984 compared with 1985. Boron concentrations in plants were generally higher in 1985, but in mosquitofish and insects, boron concentrations remained about the same all 3 years. Most arsenic concentrations did not change significantly between years. (Author's abstract)
W90-08644

SELENIUM ACCUMULATION BY RACCOONS EXPOSED TO IRRIGATION DRAINWATER AT KESTERSON NATIONAL WILDLIFE REFUGE, CALIFORNIA, 1986.
Patuxent Wildlife Research Center, Laurel, MD.
D. R. Clark, P. A. Ogasawara, G. J. Smith, and H. M. Ohlendorf.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 6, p 787-794, November 1989. 4 fig, 2 tab, 24 ref. Bureau of Reclamation Intra-agency Agreement 6-AA-20-04170.

Descriptors: *Agricultural runoff, *Bioaccumulation, *Irrigation water, *Kesterson Reservoir, *Path of pollutants, *Raccoons, *Selenium, *Water pollution effects, Animal tissues, California, Drainage water, Heavy metals, Tissue analysis, Volta Wildlife Area.

In February-March 1986, eight raccoons were collected at Kesterson Reservoir (Merced Co., CA), which had received selenium-contaminated irrigation drainwater, and four raccoons were collected at the nearby Volta Wildlife Area, which had not. Selenium concentrations in Kesterson raccoons averaged 19.9 ppm (micrograms/g dry weight) in liver, 28.3 ppm (dry weight) in hair, 21.6 ppm (dry weight) in feces, and 2.61 ppm (wet weight) in blood and exceeded Volta concentrations by 12, 30, 21, and 10 times. Selenium concentrations in livers of Kesterson raccoons were less than those in five of nine other mammal species sampled in 1984. Selenium concentrations in hair provided the strongest statistical separation between study areas. Hemoglobin levels in two Kesterson raccoons equaled levels reported in rats with selenium-induced anemia, but the raccoons showed no illness. Amyloidosis in one Kesterson raccoon may have been selenium-induced. These data indicate that raccoon births peaked about 2 months later than was previously reported. Based on this sample of 12 raccoons, no evidence was found that contamination by irrigation drainwater had negative effects on raccoons inhabiting Kesterson. (Author's abstract)
W90-08645

VARIATIONS OF HEAVY METALS AND ARSENIC IN FISH AND OTHER ORGANISMS FROM THE CALCASIEU RIVER AND LAKE, LOUISIANA.
McNeese State Univ., Lake Charles, LA. Dept. of Chemistry.
G. J. Ramelow, C. L. Webre, C. S. Mueller, J. N. Beck, and J. C. Young.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 6, p 804-818, November 1989. 2 fig, 12 tab, 26 ref, append. DOE Grant DE-FG01-83EP31111.

Descriptors: *Arsenic, *Bioaccumulation, *Calcasieu Lake, *Calcasieu River, *Estuarine fisheries, *Fish, *Heavy metals, *Louisiana, *Path of pollutants, Cadmium, Chromium, Copper, Estuaries, Lead, Mercury, Oysters, Periphyton, Shellfish, Silver, Tissue analysis, Zinc, Zooplankton.

The edible portions of several species of fish and other marine organisms inhabiting the Calcasieu

River/Lake, LA, were analyzed for cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), silver (Ag), zinc (Zn), and arsenic (As). Concentrations of all metals measured in both intraspecies and interspecies showed no significant variation with sample location. Differences in elemental concentrations were related to organism mobility and not to site-specific variations in metal loadings. Different species of finfish contained only trace amounts of Cd (0.02 to 0.08), Ag (< 0.01 to 0.3), Pb, (< 0.2 to 0.5), and As (< 0.1 to 0.3) mg/kg. concentrations of Cu and Cr were highly variable, in contrast to Zn, which was present in relatively constant amounts across all species (28 +/-7 mg/kg). Sessile organisms such as oysters had the highest concentrations of heavy metals, including Cd. Periphyton and zooplankton were the only groups that showed differences in metal concentrations with sampling location. (Author's abstract)
W90-08647

SIZE-DEPENDENCE OF MERCURY(II) ACCUMULATION KINETICS IN THE MOSQUITOFISH, GAMBUSIA AFFINIS (BAIRD AND GIRARD).
Savannah River Ecology Lab., Aiken, SC.
M. C. Newman, and D. K. Doubet.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 6, p 819-825, November 1989. 4 fig, 1 tab, 46 ref. US DOE Contract DE-AC09-76SR00-819.

Descriptors: *Bioaccumulation, *Gambusia, *Mercury, *Methylmercury, *Path of pollutants, Bioassay, Fish physiology, Heavy metals, Kinetics.

Size-dependence of mercury(II) accumulation from water by the mosquitofish, Gambusia affinis was assessed under controlled laboratory conditions. Uptake rates were higher for smaller fish than for larger fish, however, variation between individuals precluded development of a statistical model for size-dependent Hg accumulation. The mean (plus or minus standard deviation (S.D.)) uptake rate for mosquitofish exposed to 0.24 micrograms/L of Hg was 0.32 +/-0.15 micrograms/g dry weight/day. Uptake rate constants were similar for the Hg(II) and Hg(0) as reported elsewhere. Both inorganic species (Hg(II) and Hg) were accumulated faster than methylmercury. Elimination rate constants averaged 0.53 +/-0.14/day (1 S.D.) and were independent of mosquitofish size. (Ver-Nooy-PTT)
W90-08648

EXTRACTION OF ORGANOTIN COMPOUNDS FROM POLYVINYL CHLORIDE PIPE.
Georgia Inst. of Tech., Atlanta. School of Chemical Engineering.
W. Wu, R. S. Roberts, Y.-C. Chung, W. R. Ernst, and S. C. Havlicek.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 6, p 839-843, November 1989. 5 fig, 2 tab, 8 ref, append. EPA Grant R8048300010.

Descriptors: *Leaching, *Organotin compounds, *Pipes, *Plastics, *Polyvinyl chloride, *Tin, *Water pollution sources, Diffusion, Drinking water, Mass transfer, Path of pollutants, Polymers.

Polyvinyl chloride (PVC) is a widely used plastic material, and when used for rigid PVC pipe extrusion, is commonly heat stabilized by addition of organotin compounds. The extraction (leaching) of organotin stabilizers from commercial polyvinyl chloride pipe into flowing ultra-high purity water was examined as a function of time and flow rate. A recirculation system which consisted of 46 meters of pipe was used in the dynamic tests. The extraction rates for 1.9 cm diameter pipe from two different manufacturers followed a decaying exponential function and decreased significantly during a period of four hours of water recirculation. Dissolved organotin concentration reached 95% of its steady state value within about 12 hours. The extraction resulted from organotin at or near the inner wall of the pipe. Diffusion of organotin from

the bulk of the pipe wall to the inner wall was apparently negligible. Mass transfer coefficients for the extraction process were correlated with Reynolds number. Results suggest that the concentration of tin in water flowing though several hundred meters of new (unextracted) pipe could exceed the recommended maximum safe level of 20 mg/cu m. The extraction rate, however, can be lowered to a safe level by rinsing the pipe for a period of four hours at a Reynolds number of 6000 or more. (Author's abstract)
W90-08651

MOVEMENT OF DISSOLVED RADIONU-CLIDES FROM SUBMERGED URANIUM MINE TAILINGS INTO THE SURFACE WATER OF LANGLEY BAY, SASKATCHE-WAN, CANADA.
Environmental Protection Service, Regina (Saskatchewan).
D. T. Waite, S. R. Joshi, and H. Sommerstad.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 6, p 881-887, November 1989. 5 tab, 2 fig, 15 ref.

Descriptors: *Acid mine drainage, *Canada, *Lake sediments, *Mine wastes, *Path of pollutants, *Radioisotopes, *Sediment contamination, *Uranium radioisotopes, Langley Bay, Lead radioisotopes, Mine drainage, Radium radioisotopes, Saskatchewan, Sediment analysis, Thorium radioisotopes, Water pollution sources.

The Gunnar mine operated in northern Saskatchewan, Canada from 1955 to 1964, extracting uranium from approximately 5,000,000 tons of ore by the sulfuric acid leach process. Large quantities of the acidic tailings were discharged, covering the entire bottom of Langley Bay and forming a delta. Measurements of in situ sediments showed release rates of up to 14.8 picoCuries (pCi) Pb-210 (lead) and 155.6 pCi Ra-226 (radium) per sq m per hour along with traces of Th-228 (thorium) and uranium into the surface water of the bay. It was calculated that, at this rate, it would take 5.5 days for the Ra-226 concentrations to reach the ambient concentrations of 4.8 pCi/L found in Langley Bay surface water. Comparing this with the reported 14-day hydraulic retention time for the bay, the flux or radionuclides from the sediments can account for the entire concentration measured in the surface water. (Author's abstract)
W90-08653

HIGH PERFORMANCE LIQUID CHROMATO-GRAPHIC SEPARATION OF FISH BILIARY POLYNUCLEAR AROMATIC HYDROCAR-BON METABOLITES.
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 5A.
W90-08655

TOXICITY AND UPTAKE OF NITROGUANI-DINE IN PLANTS.
Agricultural Research Service, Stoneville, MS. Cotton Physiology and Genetics Unit.
J. J. Heitholt, R. H. Hodgson, and T. J. Tworkoski.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 5, p 751-758, May 1990. 2 fig, 4 tab, 11 ref. Army Biomedical Research and Development Command Project 87PP7815.

Descriptors: *Ecotoxicology, *Explosives wastes, *Grasses, *Munitions wastes, *Nitroguanidine, *Toxicity, *Wastewater utilization, Absorption, Bioaccumulation, Chlorophyll, Fescues, Hydroponics, Industrial wastewater, Magnesium, Metabolism, Path of pollutants, Plant growth, Potassium, Soybeans, Sublethal effects, Water pollution effects.

Land application of wastewater contaminated with nitroguanidine (NQ), generated during production of the munition nitroguanidine, will result in NQ penetration into the root zone where the potential for absorption exists. This study was undertaken to test the toxicity of and to characterize the uptake of NQ in plants. Two-week old hydroponically grown soybean plants (Glycine max L. Merr., cv. Williams) were exposed to 0, 2, or 4 mM NQ in the hydroponic solution for 11 days. Solutions of NQ were also applied on the pot soil (on alternate days for a total of 5 applications) of 23 to 30 day old soybean plants, tall fescue (Festuca arundinacea Schreb.), and smooth bromegrass (Bromus inermis Leyss.). Soybean dry matter and concentrations of leaf chlorophyll and Mg were reduced by 2 and 4 mM NQ in hydroponic culture. In soil, soybeans produced less dry matter as the concentration of NQ in the solutions applied to the soil increased from 0 to 8 mM NQ. Dry matter of fescue plants was significantly reduced only by 8 mM NQ (0.51 g/plant), and bromegrass dry matter was unaffected by NQ treatment. While calcium concentrations of the grasses were affected by 4 and 8 mM treatment, there was no significant effect of NQ on leaf chlorophyll, magnesium, or potassium concentrations of the grasses. Results indicate that the differential toxicity of NQ between species is due to differential sensitivity and not due to soybean's greater accumulation and greater leaf NQ concentrations exhibited at each NQ concentration. The greater uptake and leaf NQ concentration in soybean compared to tall fescue suggest that the roots of these two species differ in their permeability to NQ. Since extracts of radiolabeled leaves and roots did not indicate the presence of any metabolite in either species, the biochemical events related to the differential toxicity between species also remains unknown. (VerNooy-PTT)
W90-08657

LEAD AND CADMIUM CONCENTRATIONS IN MARINE ORGANISMS FROM THE TAR-RAGONA COASTAL WATERS, SPAIN.
Barcelona Univ., Tarragona (Spain). Lab. of Toxicology and Biochemistry.
M. Schuhmacher, M. A. Bosque, J. L. Domingo, and J. Corbella.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 5, p 784-789, May 1990. 1 fig, 2 tab, 16 ref.

Descriptors: *Bioaccumulation, *Cadmium, *Crustaceans, *Lead, *Marine fisheries, *Mollusks, *Path of pollutants, *Shellfish, *Spain, Coastal waters, Fish, Heavy metals, Tissue analysis.

Lead and cadmium are now recognized to be two of the most important heavy metal contaminants of the marine environment. The Tarragona coastal area (Catalonia, NE Spain) is a biologically productive and physically diverse marine ecosystem, with a very important commercial fishing industry. In this study, the distribution and concentrations of lead (Pb) and cadmium (Cd) in marine species commonly consumed by the population of Tarragona was determined. Twenty-five to 33 specimens of each species were randomly purchased from local fishermen, except for lobsters, where only six were used. Specimens investigated included: lobster, shrimp, sardines, anchovies, crabs, mussels, snails, clams, oysters, squid, cuttlefish, and octopus. Analysis of tissues showed that both metals are accumulated to a greater or lesser extent by the 23 species investigated. Lead concentrations (in micrograms/kg wet weight) varied from < 15 (detection limit) to 2387.2. For cadmium, the values were from < 2 (detection limit) to 6449.9 micrograms/kg wet weight. In general, crustacean and molluscan species showed higher concentrations of Pb and Cd. The levels of the Pb and Cd determined in the species collected in the Tarragona coastal area, an area particularly exposed to pollution inputs from the Ebro and Francoli Rivers, would not pose a health hazard for consumers. (VerNooy-PTT)
W90-08661

EFFECT OF SEDIMENT CONTACT AND UPTAKE MECHANISMS ON ACCUMULA-TION OF THREE CHLORINATED HYDRO-CARBONS IN THE MIDGE, CHIRONOMUS RIPARIUS.
Ohio State Univ., Columbus. Environmental Biology Program.
D. M. Fry, and S. W. Fisher.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 5, p 790-797, May 1990. 3 tab, 15 ref.

Descriptors: *Bioaccumulation, *Chlorinated hydrocarbons, *DDE, *Midges, *Path of pollutants, *Pentachlorophenol, *Polychlorinated biphenyls, *Sediment contamination, Absorption, Bioassay, Bottom sediments, Comparison studies, Larvae, Olentangy River, River sediments.

Since they inhabit bottom sediments, benthic organisms are at great risk from sediment-sorbed contaminants such as chlorinated hydrocarbons. In this investigation, uptake of sediment-sorbed 5,5'6-trichlorobiphenyl (PCB), p,p'-DDE and pentachlorophenol (PCP) by the midge (Chironomus riparius) was examined under three conditions. Uptake from direct contact with contaminated sediment (sediment plus water; treatment A) was compared to uptake levels by the midge when it was screened from contaminated sediment contact (screened sediment; treatment B) and to uptake in dead organisms exposed to contaminated sediment (passive; treatment C). For all tests, groups of 50 fourth instar midge larvae were exposed for 24 hours to 5 g of Olentangy River sediment contaminated by either 10 microliters DDE, 50 microliters PCB, or 25 microliters PCP. With all three compounds, midges in treatment A accumulated significantly more parent compound than the midges in treatment B. The midges accumulated an average of 10 times more parent compound when sediment contact was made. Passive uptake of PCP by midges (treatment C) was greater than uptake when the organism was alive (treatment A), but for PCB and DDE, midges accumulated significantly less by passive uptake. Sediment was the primary sink for PCB and DDE in every treatment. With PCP, however, the majority of the compound was found in the organism, except for the screened sediment treatment (B), where the levels in the sediment extract and midge were very close. Results from this study suggest that the midge accumulated significantly more neutral lipophilic and ionizable compounds when it is in direct contact with bottom sediments. Results also indicate that passive uptake occurs with neutral lipophilic and ionizable compounds, but is only a crucial mechanism of uptake for the latter. (VerNooy-PTT)
W90-08662

CONCENTRATIONS OF SELECTED CHLOR-INATED PESTICIDES IN SHRIMP COLLECT-ED FROM THE CALCASIEU RIVER/LAKE COMPLEX, LOUISIANA.
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
H. E. Murray, and J. N. Beck.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 5, p 798-804, May 1990. 1 tab, 1 fig, 10 ref. DOE Grant No. DE-FG01-83EP31111.

Descriptors: *Bioaccumulation, *Calcasieu River, *Chlorinated hydrocarbons, *Halogenated pesticides, *Louisiana, *Path of pollutants, *Pesticides, *Shrimp, Aldrin, Animal tissues, Benzene hexachloride, DDD, Endrin, Estuaries, Estuarine environment, Heptachlor, Tissue analysis.

Portions of the Calcasieu River Basin in Louisiana are extensively developed, particularly Greater Lake Charles. The section most affected by this development is the Calcasieu Estuary from the salt water barrier to the Intracoastal Waterway. Because of the economic importance of the shrimping industry to southwest Louisiana, the objective of this study was to analyze shrimp collected from the Calcasieu River/Lake Complex for the presence of selected chlorinate pesticides. White shrimp (Penaeus setiferus) and brown shrimp (Penaeus aztecus) were collected from the Calacasieu River south of the salt water barrier and three major tributaries. Shrimp containing various concentrations of chlorinated pesticides including beta-BHC (benzene hexachloride), delta-BHC, heptachlor, aldrin, DDD, endrin, endosulfan II, and endrin aldehyde were distributed throughout the estuarine system. Amounts in edible shrimp tissue varied from less than 0.01 micrograms/g to 5.36 micrograms/g (for endrin). In general, the upper portion of the estuarine system (including

the bayous) yielded the highest concentrations of pollutants found. (VerNooy-PTT)
W90-08663

TRIHALOMETHANES IN THE WATER SUPPLIES OF SARDINIA, ITALY.
Cagliari Univ. (Italy). Inst. of Hygiene.
A. Contu, M. Bordigoni, G. Sarritzu, G. Premazzi, and M. Pudda.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 5, p 805-812, May 1990. 1 fig, 3 tab, 18 ref.

Descriptors: *Groundwater pollution, *Italy, *Potable water, *Surface water, *Trihalomethanes, Bromides, Chemical analysis, Chlorine, Drinking water, Population exposure, Public health, Reservoirs, Water sampling, Water supply.

For halogenated compounds, including trihalomethanes (THMs), Italian law has fixed a limit value of 30 micrograms/L, to be in force in 5 years. This study evaluated THM concentrations in the water distributed in different villages in the province of Cagliari, in the south of Sardinia, Italy. During the period spring-autumn 1986, 113 water samples were collected along the three main water distribution networks. Samples were analyzed for residual chlorine, total THM, and the most common forms of THMs. In the Flumendosa-Mulargia water system, higher values of total THM have been observed in lake water samples (average = 54.3 micrograms/L) with respect to groundwater (average = 10.8 micrograms/L). Among the different THMs the concentration of bromoform is higher in groundwater than in surface water. In the Sulcis water system, all the 17 surface water samples presented total THM values higher than 30 micrograms/L, the mean value being equal to 73.3 micrograms/L, while the well water samples did not exceed 22.5 micrograms/L (average = 11.3). In the Sarrabus water system, total THM levels were significantly lower than those measured in the two previous systems, with the exception of some springs where bromide compounds reached maximum values of about 6.4 micrograms/L. On the basis of the proved carcinogenic effects of THMs, epidemiological studies are needed in order better predict effects of these compounds on the resident population of about 500,000 (over 30 years exposure), and on the 6 million tourists who visit the area every year. (VerNooy-PTT)
W90-08664

ACCUMULATION OF METALS AND HISTOPATHOLOGY IN OREOCHROMIS NILOTICUS EXPOSED TO TREATED NNPC KADUNA (NIGERIA) PETROLEUM REFINERY EFFLUENT.
Ahmadu Bello Univ., Zaria (Nigeria). Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W90-08665

ORGANIC MICROPOLLUTANTS IN LAKES: A SEDIMENTOLOGICAL APPROACH.
Istituto di Ricerca sulle Acque, Brugherio (Italy).
S. Galassi, A. Provini, and A. De Paolis.
Ecotoxicology and Environmental Safety EESADV, Vol. 19, No. 2, p 150-159, April 1990. 3 fig, 3 tab, 15 ref.

Descriptors: *Lake sediments, *Organophosphorus compounds, *Path of pollutants, *Polycyclic aromatic hydrocarbons, *Risk assessment, *Sediment analysis, Effluents, Italy, Lipids, Phosphates, Sediment contamination.

Many very persistent and lipophilic compounds, considered to be of concern for chronic toxicity and bioaccumulation, are generally present in surface waters at very low and variable concentrations. Sediments represent a concentrated pool for these compounds and consequently they are often analyzed instead of water. Some theoretical models have been proposed recently in order to estimate the concentration of these pollutants in water and their potential risk for aquatic biota and human health. In this work, sediments from three subalpine lakes located in Northern Italy, very close to

each other but with different anthropogenic loads, were collected at several stations for determination of the classes of organic micropollutants of urban, industrial, and agricultural origin. Results show that urban and industrial pollution are predominant in this area. Two classes of micropollutants seem to be most related to anthropogenic activities: polycyclic aromatic hydrocarbons (PAHs) and trichloroalkyl phosphates. The PAHs reach lake sediments through atmospheric deposition and point sources; the alkyl phosphates, present only in two lakes, are more likely to be due to industrial effluents. Sediment monitoring appears to be a very useful tool to check long-term contamination in the aquatic environment and to follow the historical trend of persistent and accumulable contaminants. However the use of the sedimentological approach for risk assessment seems at present to be infeasible since: (1) for some pollutants aquatic biota is exposed to water concentrations lower than those calculated by equilibrium models; (2) some sediments seem to be in equilibrium with water, but their level in recent sediments is often lower than the detection limit of the most common analytical techniques; and (3) the choice of chemical classes representative of anthropogenic pollution is a very difficult problem in developed countries. (VerNooy-PTT)
W90-08668

MATHEMATICAL MODEL FOR CADMIUM IN THE STONE LOACH (NOEMACHEILUS BARBATULUS L.) FROM THE RIVER ECCLESBOURNE, DERBYSHIRE.
Institute of Terrestrial Ecology, Huntingdon (England). Monks Wood Experimental Station.
P. E. T. Douben.
Ecotoxicology and Environmental Safety EESADV, Vol. 19, No. 2, p 160-183, April 1990. 5 fig, 12 tab, 27 ref.

Descriptors: *Bioaccumulation, *Cadmium, *Fish, *Mathematical models, *Path of pollutants, Absorption, Ecotoxicology, Fish growth, Fish physiology, Great Britain, Heavy metals, Metabolism, Sublethal effects, Toxicity.

A mathematical model which linked from metabolism of the stone loach with cadmium (Cd) dynamics was developed using information from laboratory experiments and field studies. Three possible sources of Cd were distinguished: water, food, and sediment. Predicted results over 1 year were compared with field observations from three sites in Derbyshire. The model adequately predicted growth of fish for all three sites. Predicted Cd levels in loach were in good agreement with measured levels in fish from all three sites despite the fact that concentrations of Cd in the environment were kept constant during each simulation. The weight of the fish affected the relative importance of different pathways of Cd intake under similar conditions. Uptake from water contributed substantially to body burden even though the concentration in water was lower than that in food or in sediment. However, uptake from both food and sediment could not be ignored given the measured levels of cadmium in the field. The relative importance of uptake from the three sources also differed with site. The model showed that metabolism, affected by temperature, is important to the dynamics of Cd in the stone loach. (Author's abstract)
W90-08669

ELECTRON MICROSCOPE AUTORADIOGRAPHIC EXAMINATION OF UPTAKE BEHAVIOR OF LIPOPHILIC CHEMICALS INTO FISH GILL.
Sumitomo Chemical Co. Ltd., Takarazuka (Japan). Biochemistry and Toxicology Lab.
S. Saito, C. Tateno, A. Tanoue, and T. Matsuda.
Ecotoxicology and Environmental Safety EESADV, Vol. 19, No. 2, p 184-191, April 1990. 5 fig, 1 tab, 16 ref.

Descriptors: *Autoradiography, *Bioaccumulation, *Carp, *Electron microscopy, *Gills, *Path of pollutants, Absorption, Diffusion, Fenvalerate, Fish physiology, Insecticides, Molecular structure, Partition coefficients, Polymers, Tissue analysis.

Simple linear relationships between the partition coefficient of organic chemicals and the bioconcentration factor in fish have been well established. In this study, limiting factors for uptake in relation to the partition coefficient and molecular weight were investigated. Juvenile carp were exposed to fenvalerate and to an oligomer with molecular weights of 420 and 2,000-50,000 and partition coefficient values of 6.4 and > 14. Uptake behavior into gill tissues was observed by electron microscope autoradiography. It was qualitatively demonstrated that fenvalerate was absorbed into gill tissues and localized in membrane systems of each cell. On the other hand, no absorption was observed for the oligomer, even in the external membrane of pavement cells. These results suggest that absorption of the oligomer is limited by low diffusion into membranes due to its very high molecular weight, resulting in no bioconcentration in fish. The significance of the partition coefficient uptake behavior is also verified from the distribution behavior of fenvalerate. (Author's abstract)
W90-08670

SORPTION OF ORGANIC CONTAMINANTS.
Florida Univ., Gainesville. Dept. of Soil Science.
P. S. C. Rao.
Water Science and Technology WSTED4, Vol. 22, No. 6, p 1-6, 1990. 33 ref.

Descriptors: *Organic pollutants, *Path of pollutants, *Porous media, *Solute transport, *Sorption, Colloids, Dissolved organic carbon, Equilibrium, Kinetics, Mathematical models, Sediment contamination, Soil contamination, Vapor-phase sorption.

Sorption of organic contaminants plays a dominant role in their rate of transport through porous media such as soils, sediments, and aquifers. The rate of abiotic and biotic transformations may also be significantly altered by sorption. A brief overview of the current knowledge based on sorption of organic contaminants by natural sorbents is presented. Several issues that need further study are examined. These may include additional data on equilibrium and nonequilibrium sorption of ionogenic and ionic organic contaminants need to be collected; the development of more complex models for the sorption of these contaminants; and more research into the significance of colloids, dissolved organic carbon and suspended particulate matter, in mediating the transport of organic solutes. Partitioning into sorbent organic matter is viewed as the predominant process for sorption of nonpolar organics from aqueous solutions, and various methods have been proposed for estimating sorption/partition coefficients. Recent experimental and theoretical work has established a basis for predicting organic contaminants sorption from polar mixed solvents (mixtures of water and miscible cosolvents). Data on sorption of ionic and ionogenic organic compounds (e.g. phenols, amines) are limited, and initial efforts are underway to develop models for such sorbates. There has also been a recent resurgence of interest in studying vapor-phase sorption and transport of volatile organic compounds. Much of the early work on sorption dealt with equilibrium sorption, but considerable advances have been made in characterizing and predicting sorption nonequilibrium as well. Molecular-scale measurements are needed in order to provide direct, unequivocal evidence for selection among several contending phenomenological models proposed for describing sorption equilibrium and kinetics. (Author's abstract)
W90-08671

ADSORPTION OF A HOMOLOGOUS SERIES OF ALKYLBENZENES TO MINERAL OXIDES AT LOW ORGANIC CARBON CONTENT USING HEADSPACE ANALYSIS.
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
J. A. Perlinger, S. J. Eisenreich, P. D. Capel, P. W. Carr, and J. H. Park.
Water Science and Technology WSTED4, Vol. 22, No. 6, p 7-14, 1990. 7 fig, 16 ref.

Descriptors: *Alkylbenzenes, *Headspace analysis, *Mathematical models, *Minerals, *Oxides, *Or-

ganic pollutants, *Path of pollutants, *Sorption, Sorbent concentrations.

The extent to which hydrophobic organic contaminants will sorb to solids is expressed in most mathematical models of contaminant transport in terms of a partition coefficient. A homologous series of alkylbenzenes was sorbed to well-characterized mineral oxides in batch experiments to elucidate mechanisms of sorption in the absence of natural organic matter. Sorbed concentration was determined by measuring the headspace concentration in a closed vessel partially filled with a water/alkylbenzene/solid slurry. Partitioning of dissolved alkylbenzenes to sorbed alkylbenzenes was observed at high sorbed concentrations, the mechanism was surface adsorption limited by the surface area of the solids. Enhancement of the adsorption of individual compounds was observed when alkylbenzenes were sorbed as a mixture. (Author's abstract)
W90-08672

COMPLEXATION-ADSORPTION MODEL DESCRIBING THE INFLUENCE OF DISSOLVED ORGANIC MATTER ON THE MOBILITY OF HYDROPHOBIC COMPOUNDS IN GROUNDWATER.
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
P. Lafrance, O. Banton, P. G. C. Campbell, and J. P. Villaneuve.
Water Science and Technology WSTED4, Vol. 22, No. 6, p 15-22, 1990. 7 fig, 1 tab, 19 ref.

Descriptors: *Adsorption, *Complexation, *Dissolved organic matter, *Groundwater pollution, *Mathematical models, *Path of pollutants, Freundlich equations, Interstitial water velocity, Kinetic rate equations, Residence time, Soil properties, Sorbent transport, Sorption kinetics.

Natural dissolved organic matter found in groundwater can bind hydrophobic contaminants to form 'complexes' and possibly affect their transport in the subsurface. The mobility of trace organic contaminants in soil originating from non-point source pollution may thus be affected by complexation reactions in the unsaturated zone. In order to predict the possible impact of such interactions on contaminant retention in the soil, simulations have been made with a three-site sorption model. Two kinetic rate equations and an equilibrium Freundlich equation are used to describe possible sorption of two species of the contaminant (free or bound with dissolved organic matter) in a soil-water system. The equations governing the contaminant adsorption and the transport are simultaneously solved using an explicit-implicit finite difference technique, under steady-state water flow conditions. An analysis of the model's sensitivity to variations in the 'complex' sorption rate constants and the complexation constant demonstrated the relative importance of these processes and their effects on the vertical movement of the contaminant in soil. The influence of slow sorption kinetics for the 'complex' varies as a function of residence time in the soil column, i.e. the pore-water velocity. Sorption of the 'complex', when it does occur, diminishes the 'carrier-effect' of the complexation. If the 'complex' is non-adsorbable on soil, the transport of contaminants with complexation constant values greater than 100,000/(mol/L) will be significantly affected by dissolved organic matter concentrations typically encountered in soil-water systems. Such values for Kc are expected to apply to various potential contaminants. (Author's abstract)
W90-08673

MOBILITY OF SOLUBLE AND NON-SOLUBLE HYDROCARBONS IN CONTAMINATED AQUIFER.
Institut Francais du Petrole, Rueil-Malmaison.
J. Ducreux, C. Bocard, P. Muntzer, O. Razakarisoa, and L. Zilliox.
Water Science and Technology WSTED4, Vol. 22, No. 6, p 27-3 1990. 7 fig, 3 tab, 16 ref.

Descriptors: *Aquifers, *Groundwater pollution, *Hydrocarbons, *Oil pollution, *Path of pollut-

ants, Interfacial tension, Liquid-gas exchange, Oil recovery, Silt, Soil properties, Surfactants, Vadose zone.

After the contamination of an aquifer by petroleum products, the residual oil trapped is a constant source of pollution by the entrainment of the most soluble hydrocarbons. By studying the exchanges of residual hydrocarbons between oil-water-air and soil, it was determined that the liquid/gas exchange is major factor in the retention of soluble alkanes masking the adsorbing materials effects. For the soluble aromatic hydrocarbons, the main phenomenon observed is the liquid/solid exchange, while the residual air has no effect. The residual contamination of the vadose zone thus plays a preponderant role in the long-term pollution of a groundwater table. It is thus imperative to implement methods to prevent such harmful effects. The use of surfactants, by lowering the oil/water interfacial tension seems to be an effective method. Their adsorption onto a natural matrix was studied with different porous substrates (sand, sand/silt). Their retention on sand is poor, but it increases with silt content. This is mainly due to a cationic exchange (calcium ion/sodium ion). In order to avoid this phenomenon a salt preflush by a 10 g/L sodium chloride solution is effective. This solution allows a gas-oil recovery enhancement by reducing the loss of surfactant in the soil. Moreover, a surfactant partition between oil and water is underscored. A better understanding of these parameters would lead to the optimizing of the enhanced drainage technique for recovering residual oil trapped in an aquifer. (Author's abstract)
W90-08675

LONG TERM FATE AND TRANSPORT OF IMMISCIBLE AVIATION GASOLINE IN THE SUBSURFACE ENVIRONMENT.
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
D. W. Ostendorf.
Water Science and Technology WSTED4, Vol. 22, No. 6, p 37-44, 1990. 2 fig, 1 tab, 17 ref.

Descriptors: *Fate of pollutants, *Hydrocarbons, *Mathematical models, *Oil pollution, *Path of pollutants, Advection, Field calibration, Oil recovery, Sorption, Storage, Volatilization.

The concentration of separate phase hydrocarbons downgradient of a nineteen year old aviation gasoline spill at the US Coast Guard Air Station in Traverse City, Michigan was measured and modeled. The separate phase aviation gasoline is presumed to exist in mobile and residual partitions whose transport is modeled as a simple one dimensional balance of storage, advection, volatilization, and linear sorption. Field calibration suggests a retardation factor of 13.1, while volatilization accounts for about 30% of the originally spilled product, underscoring the importance of these two mechanisms in immiscible gasoline fate and transport studies. (Author's abstract)
W90-08676

FATE AND TRANSPORT OF PETROLEUM IN THE UNSATURATED SOIL ZONE UNDER BIOTIC AND ABIOTIC CONDITIONS.
Delaware Univ., Newark. Dept. of Civil Engineering.
J. B. Carberry, and S. H. Lee.
Water Science and Technology WSTED4, Vol. 22, No. 6, p 45-52, 1990. 9 fig, 11 ref.

Descriptors: *Fate of pollutants, *Hydrocarbons, *Microbial degradation, *Oil pollution, *Path of pollutants, *Soil contamination, Computer models, Fuel, Soil properties, Soil texture, Sorbent transport.

Two different types of soil were selected to observe the migration and/or degradation of petroleum contaminants. One soil sample was composed of fine clay and was contaminated with electrical insulating oil. The other soil sample was a coarse soil contaminated by fuel oil concentrations of indigenous microbes capable of degrading each petroleum contaminant. Four columns fabricated of plexiglass with five ports at 6 inch intervals

were filled with the contaminated soil which had been air dried and autoclaved for sterilization. These columns simulated unsaturated soil in the vadose zone. In one type of experiment, the petroleum was added just once in order to simulate a petroleum spill. In the other type of experiment, petroleum was added to the column repeatedly at measured intervals in order to simulate a petroleum leak. To the second column operated for each soil, the contaminating petroleum, water, and cultured microbes were added. From these experiments, a mass balance of petroleum contamination could be determined at all time intervals at all column depths. The sterile column behavior exhibited only physical changes such as absorption and evaporation and could be compared to results in columns of biotic conditions. These differences permitted the development of a computer model to simulate and predict physical and biological processes in fine and coarse soils. (Author's abstract)
W90-08677

BIODEGRADATION OF BTEX IN SUBSURFACE MATERIALS CONTAMINATED WITH GASOLINE: GRANGER, INDIANA.
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
J. M. Thomas, V. R. Gordy, S. Fiorenza, and C. H. Ward.
Water Science and Technology WSTED4, Vol. 22, No. 6, p 53-62, 1990. 3 fig, 6 tab, 19 ref.

Descriptors: *Benzene, *Biodegradation, *Cleanup operations, *Hydrocarbons, *Microbial degradation, *Oil pollution, *Soil contamination, *Toluene, *Water pollution treatment, *Xylenes, Ethylbenzene, Gas chromatography, Liquid scintillation, Mineralization.

The microbial ecology and potential for biodegradation of benzene, toluene, ethylbenzene, and o-xylene and m-xylene (BTEX) in core materials contaminated with unleaded gasoline were investigated. The site studied was unique because a portion of the contaminated area was biostimulated in a demonstration of the use of hydrogen peroxide as an oxygen source in in situ biorestoration. Two years after termination of the field demonstration, core samples were collected from uncontaminated, contaminated, and biostimulated areas at the site and analyzed for inorganic nutrients, microbial numbers, mineralization potential of glucose, benzene and toluene using liquid scintillation counting, and biotransformation of BTEX using gas chromatography. The subsurface microflora was active and capable of degrading a variety of compounds. Microbial numbers and contaminant biodegradation potential in samples from the biostimulated area were greater than in uncontaminated and contaminated zones. Toluene, ethylbenzene, and m-xylene were removed in all core materials, whereas o-xylene was recalcitrant. Mineralization experiments indicated that the biodegradation potential of the subsurface material from the biostimulated zone, which still contained residual hydrocarbons, remained enhanced for at least two years after the in situ biorestoration process had been terminated. (Author's abstract)
W90-08678

ASSESSMENT OF THE POTENTIAL FOR IN SITU BIOTREATMENT OF HYDROCARBON-CONTAMINATED SOILS.
Shell Research Ltd., Sittingbourne (England). Sittingbourne Research Centre.
For primary bibliographic entry see Field 5D.
W90-08679

BASIC STUDY ON TCES BEHAVIOR IN SUBSURFACE ENVIRONMENT.
Osaka Univ. (Japan). Dept. of Civil Engineering.
K. Muraoka, and T. Hirata.
Water Science and Technology WSTED4, Vol. 22, No. 6, p 79-86, 1990. 7 fig, 3 ref, append.

Descriptors: *Groundwater pollution, *Organochlorines, *Path of pollutants, *Solute transport, *Trichloroethylene, Electron capture detector,

Gas chromatography, Infiltration, Japan, Landfills, Leaching, Mass detector.

Trichloroethylene (TCE) readily infiltrates into unsaturated soil. TCE leaching from the soil due to rainwater infiltration was examined using a cylindrical column, with water falling constantly on its surface. Two elution experiments using rectangular glass tubes were conducted. Some experiments on the movement of contaminants near the groundwater surface and the solution process into groundwater were conducted to clarify aspects of the initial stage of groundwater pollution from subsurface organochlorine contaminants. The oscillation of water level seems to support the solubility and durability of groundwater contamination. A model region was monitored to explain the contamination distribution. Soil gas analysis was used to investigate the groundwater pollution. Volatiles were collected on activated charcoal glued to a wire place 30 cm below the ground surface for several weeks, then analyzed using a pyrolysis mass-detector. To shorten the investigation time, a small hole of 2 cm in diameter and 30 cm in depth was dug, then 20 ml of soil gas was sampled with an airtight syringe from the bottom of the hole. The volatile contaminants were extracted in n-hexane placed in a vial in the field. In the laboratory, the contaminants were analyzed by gas chromatography with an electron capture detector. The ion count contours were illustrated with respect to PCE, and the zone with the high value stretching from the waste landfill site in the northern part to the springs could be recognized. On the basis of this monitoring, the waste landfill site was definitely indicated to be the source of pollutants of the contaminated spring water. (Brunone-PTT)
W90-08681

FATE AND TRANSPORT OF ALACHLOR, METOCHLOR AND ATRAZINE IN LARGE COLUMNS.
Wisconsin Univ., Madison. Water Resources Center.
B. J. Alhajjar, G. V. Simsiman, and G. Chesters.
Water Science and Technology WSTED4, Vol. 22, No. 6, p 87-94, 1990. 4 fig, 15 ref.

Descriptors: *Alachlor, *Atrazine, *Herbicides, *Leachates, *Metochlor, *Nonpoint pollution sources, *Path of pollutants, *Pesticides, *Soil contamination, Autoradiography, Liquid scintillation counter, Lysimeters, Thin layer chromatography, Volatilization.

Carbo-14 ring-labelled atrazine, alachlor, and metochlor were surface-applied at 3.14 kg a.i./ha in greenhouse lysimeters containing two soils in an ongoing experiment. Bromide, a conservative tracer, at 6.93 kg/ha as potassium bromide and nitrate-nitrogen at 112 kg/ha as potassium nitrate were mixed with each herbicide and surface-applied. Growth of red top (Agrostis alba) was established in each column (105 cm long and 29.4 cm in diameter). The experiment consisted of 12 columns (2 soils x 3 herbicides x 2 replicates) each fitted with four sampling ports for leachates, a volatilization chamber, and an aeration and irrigation system. Volatile materials were trapped directly in solvents. One column replicate was dismantled for soil and plant analyses. Columns of Plainfield sand and Plano silt loam treated with alachlor and metochlor were sampled after 23 and 28 weeks, respectively; the atrazine columns after 35 weeks. Herbicide residues were determined by liquid scintillation counting, extracted and separated by thin-layer chromatography using autoradiographic detection. Volatilization was less than or equal to 0.01% of the amount of herbicide applied. The herbicide mobility was alachlor > metochlor >> atrazine. As many as 8 to 12 alachlor metabolites and 2 to 6 metochlor metabolites were separated in leachates. (Author's abstract)
W90-08682

MINERAL SAND MINING AND ITS EFFECT ON GROUNDWATER QUALITY.
Hunter District Water Board, Newcastle (Australia). Water Investigation and Planning Section.
M. N. Viswanathan.
Water Science and Technology WSTED4, Vol.

22, No. 6, p 95-100, 1990. 5 fig, 5 ref.

Descriptors: *Australia, *Gravel mining, *Groundwater pollution, *Iron, *Unconfined aquifers, Dredging, Separation, Stripping, Tomago sandbeds, Water quality standards.

Tomago sandbeds (New South Wales, Australia) is a coastal, unconfined aquifer, where mining of mineral sands, like Rutile, Zircon, Ilmenite, etc. has been in progress since 1972. Groundwater is also extracted from Tomago aquifer for urban water use. Groundwater iron levels vary from 0.1 mg/L to about 10 mg/L. Iron in excess of 0.3 mg/ L is removed by chemical treatment. Mining of mineral sands resulted in a substantial increase of iron levels, with the level of increase being site-specific. Several processes were identified as being responsible for such increases: mixing of sand by dredging, separation, and redeposition; stripping of sand at the time of mineral separation; changes in groundwater temperature, due to the open mine pond; aeration of groundwater, within the mine pond; and exposure to sunlight, within the mine pond. If water were to be extracted from the mined area, additional treatment would be required to remove the excess iron. (Author's abstract)
W90-08683

BEHAVIOR OF AQUIFERS CONCERNING CONTAMINANTS: DIFFERENTIAL PERMEABILITY AND IMPORTANCE OF THE DIFFERENT PURIFICATION PROCESSES.
Lyon-1 Univ., Villeurbanne (France). Lab. d'Hydrobiologie et Ecologie Souterraines.
J. Gibert.
Water Science and Technology WSTED4, Vol. 22, No. 6, p 101-108, 1990. 5 fig, 33 ref.

Descriptors: *Aquifer characteristics, *Fate of pollutants, *Groundwater pollution, *Karst, *Nitrates, *Path of pollutants, Agriculture, Permeability.

Contaminants in transit through groundwater systems cross different types of rocks, each one with different water-bearing characteristics. It is imperative to understand the behavior of different aquifers (porous or karstic) concerning contaminants and the relative functions and mechanisms of major processes in a given system before planning remedial measures. From the surface systems to groundwater, four main types of filter can be considered. They usually intervene simultaneously and the interactions are very strong. The activities of the different filters lead to the concept of permeability, which varies according to the efficiency of the filter, ranging from the most impermeable porous aquifers to karstic aquifers. Among major processes three groups were considered: retention, self-purification, and dilution. Nitrate profiles in a French karstic system are given, showing an increase in nitrate concentration in the epikarstic zone due to the impact of agriculture. Differences in nitrate concentrations inside this karst, could be explained by dilution, but it is possible that self purification (denitrification) takes place inside the aquifer, leading to a restoration of water quality at the base level. Other studies in small rural karst catchments have shown that nitrates are concentrated not only in the epikarst, but can also be found in the deepest layers of the karst. Deforestation and intensive farming are likely in the more-or-less long term to contaminated the deepest storage areas of karst. (Author's abstract)
W90-08684

ESTIMATION METHOD OF RESIDUAL ALKYLATING AGENTS IN WATER TREATED WITH CHLORINE-CONTAINING OXIDANT.
Changsha Inst. of Tech. (China). Dept. of Applied Chemistry.
D. Tingfa, Z. Shiguang, and T. Mousheng.
Water, Air and Soil Pollution WAPLAC, Vol. 49, No. 1/2, p 63-67, January 1990. 1 fig, 5 ref.

Descriptors: *Alkylating agents, *Chlorine, *Wastewater treatment, *Water pollution control, Chemical wastes, Organic solvents.

Alkylating materials can be an important source of pollution in water, emanating, for example, from

the effluents of certain chemical plants. In order to check the extent of the removal, an estimation of residual alkylating agents of very low concentration in chlorine-containing water is necessary. A sensitive method is described for estimating the residual alkylating agents in water after treatment with chlorine-containing oxidants. The method is based on the reaction of 4-(p-nitrobenzyl)pyridine perchlorate (NBP-hydrogen tetrachloride) with alkylating agents to form a colorless quaternary salt which becomes red in certain organic solvents, such as benzine and toluene, following treatment with alkali. After the oxidants have been quantitatively destroyed by a mixture of sodium nitrite and sodium carbonate, small amounts of alkylating agent (e.g. 2, 2'-dichlorodiethylsulfide and benzyl chloride) are detected or estimated by using NBP-hydrogen tetrachloride. The method can be used to detect and estimate ppm concentrations of alkylating agents. A recovery within 100 plus or minus 10% has been generally obtained. (Brunone-PTT)
W90-08688

URBAN STORM WATER TRANSPORT AND WASH-OFF OF CESIUM-137 AFTER THE CHERNOBYL ACCIDENT.
Uppsala Univ. (Sweden). Dept. of Hydrology.
S. Halldin, A. Rodhe, and B. Bjurman.
Water, Air and Soil Pollution WAPLAC, Vol. 49, No. 1/2, p 139-158, January 1990. 6 fig, 6 tab, 14 ref.

Descriptors: *Cesium radioisotopes, *Chernobyl, *Path of pollutants, *Radioactivity, *Rainfall-runoff relationships, *Storm runoff, *Storm sewers, *Urban runoff, Contamination, Storm wastewater.

Radiation protection planning in urban areas after a radioactive fallout requires knowledge of decontamination caused by storm water transport. This report elucidates the transport of cesium-137 from a roof and three storm sewers in Uppsala during the first rainfall after those, on April 29-30, 1986, which caused the Chernobyl contamination. Runoff and concentration of cesium-137 in storm water were determined with an accuracy of 10 to 15%. The origin of storm water was determined from its content of oxygen-18. Surface contamination was measured on July 3, 1986. Total fallout was 25 kBq/sq m. During the rainfall on May 11, 4 kBq/sq m were transported from the roof and approximately 1 kBq/sq m from the sewered areas. From April 30 to July 4 there was a decontamination of 13 to 20 kBq/sq m. Measurements from another project showed that the fallout rain events washed off 10 to 16 kBq/sq m. The washoff by the small rainfall on May 11 constituted one-third of the remaining decontamination occurring up until July 4. The transport of cesium-137 during the May 11 event increased when the runoff increased, but was less effective as the event proceeded. The relations between cesium-137 concentration and runoff implied that the wash-off of cesium-137 in Uppsala was totally dominated by that bound to particles. (Author's abstract)
W90-08690

EFFECT OF DRAINAGE ON NUTRIENT RELEASE FROM FEN PEAT AND ITS IMPLICATIONS FOR WATER QUALITY: A LABORATORY SIMULATION.
Sheffield Univ. (England). Dept. of Geography.
A. L. Heathwaite.
Water, Air and Soil Pollution WAPLAC, Vol. 49, No. 1/2, p 159-173, January 1990. 1 fig, 5 tab, 37 ref.

Descriptors: *Drainage, *England, *Nutrients, *Peat, *Waterlogging, Aeration, Calcium, Magnesium, Nitrogen, Sulfur, Water pollution sources, Water quality.

The effect of peat moisture status on nitrogen, sulfur, calcium, and magnesium release to drainage waters was examined using a constant temperature laboratory incubation. Peat samples originating from drained and undrained sites in West Sedgemoor, Somerset Levels, southwest England were compared. Three treatments: long term waterlog-

Group 5B—Sources Of Pollution

ging, aeration, and fluctuating aeration and water-logging were imposed on all peat samples. These treatments resulted in different rates and total amounts of nitrogen, sulfur, calcium, and magnesium release, with waterlogging resulting in highest solute release. The total amounts and rates of release of sulfur, calcium, and magnesium from peat that was undrained prior to incubation always exceeded that from drained site peat samples regardless of peat moisture status. Although the degree of waterlogging or aeration affected the rate and total amount of water soluble nitrogen released during incubation, there was no difference between peat that was drained, and peat that was undrained, prior to incubation. Drainage of currently undrained and waterlogged peat in West Sedgemoor will result in the transfer of high concentrations of sulfur, calcium and magnesium from the peat in the drainage ditch. (Author's abstract)
W90-08691

FIELD TEST ON THE FATE OF TWO-STROKE LUBRICANTS IN WATER RESULTING FROM INTENSIVE OUTBOARD MOTOR OPERATION (FREILANDUNTERSUCHUNGEN UBER DEN IMMISSIONSVERLAUF VON ZWEITAKT-SCHMIERMITTELN IM GEWASSER BEI INTENSIVEM BETRIEB EINES AUSSENBORDMOTORS).
Bayerische Landesanstalt fuer Wasserforschung, Munich (Germany, F.R.).
V. B. Wachs, and H. Wagner.
Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 23, No. 1, p 1-11, February 1990. 6 fig, 5 tab, 14 ref. English summary.

Descriptors: *Boating, *Fate of pollutants, *Hydrocarbons, *Oil pollution, *Path of pollutants, *Recreation wastes, *Water pollution sources, Lubricants, Monitoring.

In 1980, the Bayerische Landesanstalt fur Wasserforschung (Bavarian Water Research Agency) ran a field test, monitoring the concentrations of hydrocarbons in water during and after intensive motor boating. The test was run in a 100 by 20 m testpond, filled with freshwater from the river Isar. A 3.3 m long testboat, equipped with a 7 kilowatt mixed lubricated two-stroke outboard motor running at 3500 revolutions/minute, was driven 600 times over the same longitudinal track over a period of 8 hours. For the first half of the test, synthetic lubricant was used in a 100:1 mix, followed by mineral oil at 50:1. During this test, a total of 16.27 L of fuel was consumed in 345 minutes of actual driving. In the first half of the test, the motor was actually run for a total of 166 minutes and consumed 7.88 L of a 100:1 with a synthetic lubricant. The hydrocarbon concentrations in the testpond at the surface and at 0.2 m and 1.5 m depth, showed at most an insignificant increase as the average measurements remained well within the statistical dispersion area. Under these test conditions, the use of this synthetic lubricant at 100:1 in intensive two-stroke outboard motor usage, did not result in a measurable increase of the hydrocarbon concentrations. During the second half of the test, a 50:1 mix with a mineral oil was used. The motor ran a total of 179 minutes and consumed 8.39 L of the two-stroke mixture. During this part of the test, there was a clear increase of the hydrocarbon level at the surface. The concentrations were much lower than what might have been expected on the basis of know emission factors. Even under the intensive usage conditions during this test, the hydrocarbon concentrations remained far below known acute toxicity limits of both lubricants. (Author's abstract)
W90-08692

MERCURY CONTENT OF COPEPODS (CRUSTACEA) COLLECTED FROM THE ANTARCTIC SEA.
Kumamoto Univ. (Japan). Aitsu Marine Biological Station.
R. Hirota, Y. Fukuda, J. Chiba, S. Tajima, and M. Fujiki.
Proceedings of the NIPR Symposium on Polar Biology, No. 2, p 65-70, September 1989. 1 fig, 2 tab, 12 ref.

Descriptors: *Antarctica, *Copepods, *Heavy metals, *Mercury, *Zooplankton, Inorganic mercury, Methylmercury, Pollutant identification, Sediment contamination.

Inorganic and methylmercury in copepods collected from nine stations in the waters around Antarctica in December 1985 and February 1986 was measured. There was considerable variation of inorganic mercury in copepods at all stations, but inorganic mercury in copepods from deeper (bottom) waters was higher than in those from surface waters. This result indicates that the inorganic mercury concentrated in the copepods might have been derived from bottom sediments and/or bottom waters. In contrast, the methylmercury content of copepods was generally low with little regional or vertical differences. Its concentration was considered to be the standard value in sea areas that are believed to be non-polluted from human activities. The mercury content (mean value) in zooplankton collected from various sea areas was compared. The value of total mercury in the Antarctic waters was about the same as that in Yatsushiro-kai adjacent to polluted areas and was higher than in other non-polluted sea areas, except for the East Indian Ocean (off Java) which is affected by active submarine volcanos. The cause of the high mercury content of the Antarctic copepods is not known. (White-Reimer-PTT)
W90-08721

SIMULATION OF INTERACTIONS BETWEEN MIGRATING WHALES AND POTENTIAL OIL SPILLS.
Applied Science Associates, Inc., Narragansett, RI.
K. Jayko, M. Reed, and A. Bowles.
Environmental Pollution ENPOEK, Vol. 63, No. 2, p 97-127, 1990.

Descriptors: *Animal behavior, *Mathematical models, *Model studies, *Oil spills, *Path of pollutants, *Water pollution effects, *Whales, Alaska, Beaufort Sea, Diving, Migration, Surfacing.

A numerical model system was developed to quantify the probability of endangered bowhead whales and gray whales encountering spilled oil in Alaskan waters. Migration and diving-surfacing models for bowhead and gray whales, and an oil spill trajectory model comprise the system. The migration models were developed from conceptual considerations, then calibrated with and tested against observations. The distribution of whales is represented in space and time by discrete points, each of which may represent one or more whales. The movement of a whale point is governed by a random walk algorithm which stochastically follows a migratory pathway. Stochastic diving-surfacing models are used to simulate surfacing behavior sequences for each species. The oil spill model accounts for oil transport and spreading in open water and in the presence of sea ice. Historical wind records and ice cover data sets provide the environmental conditions to generate stochastic oil spill scenarios. The oil spill, whale migration and diving-surfacing models are linked to provide quantitative estimates of whale-oil interactions. The model system was applied to the Alaskan Beaufort Sea to investigate the probability that bowhead whales would encounter oil spilled in this region. (Author's abstract)
W90-08730

EVALUATION OF TRANSPORT AND STORAGE OF (60)CO, (134)CS, (137)CS AND (65)ZN BY RIVER SEDIMENTS IN THE LOWER SUSQUEHANNA RIVER.
Maryland Dept. of Natural Resources, Annapolis. Power Plant and Environmental Review Div.
R. I. McLean, and J. K. Summers.
Environmental Pollution ENPOEK, Vol. 63, No. 2, p 137-153, 1990. 7 fig, 2 tab, 7 ref.

Descriptors: *Cesium radioisotopes, *Chesapeake Bay, *Cobalt radioisotopes, *Nuclear powerplants, *Path of pollutants, *Radioactive wastes, *Sediment contamination, *Susquehanna River, *Zinc radioisotopes, Conowingo Reservoir, Radioactivity, Sediment chemistry.

The Peach Bottom Atomic Power Station (PBAPS) has contributed measurable quantities of radioactivity to Conowingo Reservoir, and impoundment of the lower Susquehanna River. As part of an ongoing radiological assessment program, concentrations of plant-related radionuclides in sediments have been monitored in spring and fall since 1980. Mass balance estimates indicate that less than 20% of reactor released cobalt-60, zinc-65, cesium-134 and cesium-137 is present in these sediments. Significant seasonal variations in radionuclide trapping efficiency by the reservoir are not apparent. Deep core samples (about 200 cm) confirm that some, but not all, of this surface sediment radionuclide inventory remains within the reservoir, trapped in discrete locations by subsequent sediment accumulation. The remaining radionuclide mass, in dissolved or particle-associated form, appears to be transported downstream, through Conowingo Dam, to Upper Bay. The detection of PBAPS-derived radionuclides in the upper Chesapeake Bay, primarily the Susquehanna Flats, confirms the transport of these radionuclides from the lower Susquehanna River. (Author's abstract)
W90-08731

BEHAVIOUR AND FLUXES OF COPPER AND LEAD IN THE NILE RIVER ESTUARY.
Alexandria Univ. (Egypt). Dept. of Oceanography.
A. R. Abdel-Moati.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 2, p 153-165, February 1990. 4 fig, 2 tab, 28 ref.

Descriptors: *Copper, *Heavy metals, *Lead, *Nile Estuary, *Path of pollutants, Estuaries, Leachates, Water discharge.

Water samples collected from the Nile River estuary during maximum discharge period (January 1989) were analyzed for copper and lead. Both metals behaved non-conservatively during estuarine mixing. Between 11-20% and 44-53% loss was observed in dissolved copper and lead concentrations, respectively, during early estuarine transport. Ratios of dissolved and particulate metals indicated the importance of the particulate phase of copper and lead in the riverine system (>75%) as well as the increasing magnitude of the dissolved phase (>60%) of total copper and 40% of total lead at the estuary mouth. Chemical leaches of particulate matter showed that both metals are partitioned among the free oxide, organic and lattice phases with a tendency towards the organic phase for copper and the oxide phase for lead. About 110 tons of copper and 50 tons of lead are transported annually through the Nile River to the southeastern Mediterranean water, constituting more than 50% of both metals reaching the basin from land-based sources. The estimated lead flux through the Nile River does not exceed 2% of the total lead exported to the Mediterranean Sea through rivers. (Author's abstract)
W90-08735

DETERMINATION OF PALLADIUM AND PLATINUM IN SEAWEED.
Korea Ocean Research and Development Inst., Seoul (Republic of Korea). Polar Research Div.
For primary bibliographic entry see Field 5A.
W90-08738

PRINCIPLES OF HAZARDOUS MATERIALS MANAGEMENT.
For primary bibliographic entry see Field 5E.
W90-08751

MOBILITY AND DISTRIBUTION OF SELENIUM AND SALINITY IN GROUNDWATER AND SOIL OF DRAINED AGRICULTURAL FIELDS, WESTERN SAN JOAQUIN VALLEY OF CALIFORNIA.
Geological Survey, Sacramento, CA.
R. Fujii, and S. J. Deverel.
IN: Selenium in Agriculture and the Environment, SSSA Special Publication No. 23, 1989. Soil Science Society of America and American Society of Agronomy, Madison, WI. p 195-212, 10 fig, 1 tab,

32 ref.

Descriptors: *Agricultural runoff, *Groundwater pollution, *Path of pollutants, *Salinity, *San Joaquin Valley, *Selenium, *Soil contamination, California, Chemical reactions, Drainage, Leaching.

A study was undertaken to investigate the distribution of selenium (Se) and salinity in shallow groundwater and soil in three drained agricultural fields in the western San Joaquin Valley, California. Groundwater and soil samples were collected along transects in fields that differed in age of the drainage systems (15, 6, and 1.5 yr) and in the Se concentrations of the drain water (430, 58, and 3700 microgm/L). Isotopic enrichment and chemical composition of groundwater samples indicated that saline-enriched and Se-enriched water has evolved due to evaporation of shallow groundwater. This evaporated, isotopically enriched water containing elevated concentrations of Se is being displaced toward the drains by less saline irrigation water that percolates through the soil. Soluble Se, mainly selenate (SeO4(2-)), is also being leached from the soil and moved toward the groundwater by irrigation water. For the field drained for 15 yr, 5% or less of the total Se in one soil profile was soluble or adsorbed. Analyses of one soil profile in the field drained for only 1.5 yr indicated that soluble plus adsorbed Se in the soil accounted for < 15% of the total Se in the top 1.2 m but increased to 80% of the total Se at a depth of 2.7 m. Soil leaching, especially in fields with recently installed drainage systems, can contribute substantial quantities of Se to the groundwater. (Author's abstract)
W90-08756

PREDICTING THE OCCURRENCE OF ACID MINE DRAINAGE IN THE ALLEGHENIAN COAL-BEARING STRATA OF WESTERN PENNSYLVANIA; AN ASSESSMENT BY SIMULATED WEATHERING (LEACHING) EXPERIMENTS AND OVERBURDEN CHARACTERIZATION.
Pennsylvania State Univ., University Park. Materials Research Lab.
J. L. Morrison, B. E. Scheetz, D. W. Strickler, E. G. Williams, and A. W. Rose.
IN: Recent Advances in Coal Geochemistry. Geological Society of America Special Paper 248, 1990. p 87-99, 6 fig, 5 tab, 48 ref.

Descriptors: *Acid mine drainage, *Coal mining effects, *Pennsylvania, *Simulation analysis, *Water pollution sources, *Weathering, Acidity, Carbonates, Geohydrology, Geologic formations, Geologic mapping, Iron, Leaching, Overburden, Path of pollutants, Pyrite, Shales, Sulfur.

Simulated weathering experiments on coals and shales demonstrate that the critical factors responsible for the generation of acid mine drainage are the amounts of total sulfur, total carbonate, and the surface area of the pyrite. Total sulfur and carbonate carbon contents differ markedly among paleoenvironments whose distribution has been mapped for the Alleghenian strata of western Pennsylvania. Freshwater shales have a mean total sulfur content of 0.15% and a mean carbonate carbon content of 0.54%. Brackish shales have a mean total sulfur content of 2.40% and a mean carbonate carbon content of 0.14%. Marine shales have a mean total sulfur content of 0.95% and a mean carbonate carbon content of 0.63%. In the simulated weathering experiments, the amount of acidity, sulfate, and total iron exhibit a well-defined positive linear relation with total sulfur in samples whose carbonate carbon content is < or = 0.01%. Where carbonate carbon contents are > 0.01%, the amount of acidity, sulfate, and total iron is considerably less, and the linear relation no longer exists. Anomalously high amounts of acidity, sulfate, and total iron were encountered in both samples devoid of and containing carbonate and were associated with samples containing a high relative percentage of framboidal pyrite and/or pyrite having a high specific surface area. Because determination of the percentage of framboidal pyrite is subjective, direct measurement of pyrite surface area is preferred. (Author's abstract)
W90-08758

HEALTH RISK ASSESSMENT OF TRICHLOROFLUOROMETHANE IN CALIFORNIA DRINKING WATER.
California Univ., Davis. Dept. of Environmental Toxicology.
For primary bibliographic entry see Field 5C.
W90-08759

AIR POLLUTION IN THE WIND RIVER MOUNTAIN WILDERNESS: A LONG-TERM MONITORING PROGRAM OF THE FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE.
Bridger-Teton National Forest, Jackson, WY.
For primary bibliographic entry see Field 5C.
W90-08835

EFFECT OF A MAJOR WILDFIRE ON WATER QUALITY IN SOUTHEASTERN BRITISH COLUMBIA.
British Columbia Ministry of Forests, Nelson. Forest Science Section.
For primary bibliographic entry see Field 2E.
W90-08871

DEFINING ACIDIFICATION STATUS OF UNGLACIATED HEADWATER APPALACHIAN CATCHMENTS.
Pennsylvania State Univ., University Park. School of Forest Resources.
W. E. Sharpe, D. R. DeWalle, and B. R. Swistock.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 517-525, 3 fig, 3 tab, 13 ref.

Descriptors: *Acid rain effects, *Appalachian Mountains, *Headwaters, *Headwaters hydrology, *Sulfates, *Water pollution sources, Aluminum, Forest soils, Glaciation, Runoff.

Estimates of sulfate flux through forest soils at two unglaciated sites suggested that sulfate was not being adsorbed at either site. At one site measurements of surface water quality during acid runoff episodes indicated sulfate and aluminum export, while at the other site where severe episodes did not occur, data revealed increases in calcium in concert with increased aluminum during periods of high runoff. Determination of sulfate export from acidified watersheds alone does not adequately indicate acidification status. The finding of sulfate export from soils and watersheds during acid runoff episodes in this region of the Appalachians is inconsistent with the hypothesis that sulfate adsorption by forest soils in the Northeast is defined by the limits of glaciation. (See also W90-08822) (Author's abstract)
W90-08874

ROLE OF ATMOSPHERIC DEPOSITION IN STREAMFLOW GENERATION AND EPISODIC WATER QUALITY.
Vermont Univ., Burlington.
F. I. Potter, J. A. Lynch, and E. S. Corbett.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 527-541, 5 fig, 5 tab, 26 ref.

Descriptors: *Acid rain effects, *Acid streams, *Headwaters hydrology, *Storm runoff, *Water quality, Hydrogen ion concentration, Pennsylvania, Water chemistry, Water pollution sources.

Streamwater pH depressions as great as 2.37 units have been measured on the Leading Ridge Experimental Watersheds in central Pennsylvania. Past research has linked acidic atmospheric deposition with observed changes in streamwater chemistry. Precipitation, throughfall, soilwater, groundwater and streamwater were measured quantitatively and qualitatively on a small headwater sub-basin of L.R.E.W. Unit One in order to quantify this relationship. Two methods were employed to estimate atmospheric inputs to stormflow on a 16.5 ha study area. Direct channel precipitation was shown to produce 3.8% to 80.6% of total stormflow and up to 100% of stormflow during the rising limb of the

hydrograph. Additional atmospheric water appeared to reach the stream channel through macropore flow and other processes. Atmospheric inputs were found to explain up to 80% of the hydrogen ions in streamwater during periods of pH depressions. Increases in the concentrations of nitrate and potassium in streamwater were at times also produced by atmospheric inputs. (See also W90-08822) (Author's abstract)
W90-08875

WATER QUALITY MODELING AND TRANSPORT ANALYSIS OF HEAVY METALS IN THE CLARK FORK RIVER.
AScI Corp., Athens, GA.
K. P. Brown, and Z. Hosseinipour.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 543-552, 6 fig, 2 tab, 9 ref.

Descriptors: *Headwaters hydrology, *Heavy metals, *Mine wastes, *Model studies, *Path of pollutants, *Water pollution sources, *Water quality, Fishkill, Montana.

Loadings of dissolved and suspended metals from the stream-side mine tailings deposits in the Upper Clark Fork River, Montana, have been associated with acute and chronic mortality of brown trout. Remediation of this problem by control of important metal transport pathways is planned. The primary sources of heavy metals are the wastes from mining and refining activities that have been deposited onto the banks and flood plains of the river. These sources have been characterized using the Pesticide Root Zone Model (PRZM) and a metals speciation model (MINTEQAL). The in-stream routing is performed by an implicit finite difference model to provide hydraulics information to be used by a dynamic transport and dilution model. This study assessed the probable fate of heavy metals arriving in the river from streamside non-point sources to evaluate the potential exposure of trout to heavy metals and the probability of acute toxicity (fish kills). (See also W90-08822) (Author's abstract)
W90-08876

HYDROLOGIC CHARACTERISTICS OF A WETLAND USING A BROMIDE TRACER.
Peccia (Robert) and Associates, Helena, MT.
R. B. Morton, J. D. Goering, and D. J. Dollhopf.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 553-563, 7 fig, 2 tab, 38 ref.

Descriptors: *Acid mine drainage, *Headwaters hydrology, *Path of pollutants, *Tracers, *Wetlands, Bromides, Hydrologic properties, Monitoring wells, Montana.

Sodium bromide was used in a natural gradient tracer to determine acid mine drainage (AMD) flow velocity through a sedge peat fen in west-central Montana. A grid of auger holes and small diameter wells were installed at varying depths. Water samples taken from this grid network were analyzed in the field using a bromide specific ion electrode. Field hydraulic conductivity (K) was determined on auger holes and wells in the area of expected metal loading and tracer movement. The K ranged from 1.0 x .01 to 1.5 x .00001 cm/s with a mean of 8.3 x .0001 cm/s. Mean velocity determined from the K values was 7.1 x .00001 cm/s. Water flow velocity considered the most representative of the AMD waters was then determined by the tracer experiment and ranged from 3.1 x .1 to 6.2 x .0001 cm/s with a mean of 2.6 x .01 cm/s (73.7 ft/day). The wide range of velocities indicate a very heterogeneous wetland flow system. The large difference (three orders of magnitude) between K determined velocity and tracer determined velocity indicates the measurement of two different flow systems. The tracer velocity represents preferential flow paths within the shallow (acrotelm) system and the K determined velocity represents that flow found at greater depth (catotelm). The distance the AMD water travels, before

problem amelioration, was not determined from the tracer methods employed, but using a distance of 200m and the average tracer velocity, average residence time of AMD water in contact with wetland soils is estimated to be 9 days. (See also W90-08822) (Author's abstract)
W90-08877

MIGRATION OF RADIONUCLIDES IN THE GROUNDWATER SYSTEM FROM RESIDUAL WASTES IN A URANIUM MINE.
Weston (Roy F.), Inc., West Chester, PA.
J. Y. Yang.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 655-664, 1 tab, 5 ref.

Descriptors: *Groundwater pollution, *Headwaters hydrology, *Mine wastes, *Path of pollutants, *Radionuclides, Advection, Dispersion, Laguna, Model studies, New Mexico, Public health, Solute transport, Sorption, Uranium, Uranium radioisotopes, Water pollution sources.

Although mining at the Jackpile-Paguate mine complex in New Mexico has stopped, the nearby general public continues to be exposed to the radioactive materials remaining on the mine site. One of the potential health effects associated with uranium mine reclamation is exposure to radionuclides in the uranium-238 transformation series. The principal hydrologic pathways of potential radiation exposure in the vicinity of the Jackpile-Paguate mines are identified to be the direct pathway of ingestion of contaminated water and the indirect pathway of ingestion of meat from livestock that drink contaminated water. At present, the source of potable water in the area within 20 km (12 mi) of the mine is groundwater. Therefore, this study focuses on the migration of radionuclides in the groundwater system. A solute transport model is adapted to calculate groundwater concentrations at particular times and locations. The effects of advection, dispersion, sorption, and radioactive decay are included in the study. The results show that the potential radiological impacts from ingestion of contaminated water at the town of Laguna, about 10 km (6 mi) from the mine wastes are within the regulatory limits. (See also W90-08822) (Author's abstract)
W90-08888

POTENTIAL SOURCES OF GROUNDWATER CONTAMINATION IN THE HEADWATERS OF THE MAHANTANGO CREEK.
Agricultural Research Service, University Park, PA. Northeast Watershed Research Center.
A. S. Rogowski, and J. K. Wolf.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 665-674, 4 fig, 3 tab, 15 ref.

Descriptors: *Agricultural runoff, *Groundwater pollution, *Headwaters hydrology, *Mahantango Creek, *Nitrates, *Nonpoint pollution sources, *Path of pollutants, *Pennsylvania, *Water pollution sources, Groundwater recharge, Infiltration, Public health.

Distribution and timing of recharge on soils of a typical Pennsylvania farm in the headwaters of the Mahantango Creek is described. The descriptors include residence time in the root zone, travel time to the water table, estimated recharge rate, cumulative amount of recharge as a function of precipitation amount and the distribution of the resultant flux pulse over time at the water table. Because noninteractive agricultural pollutants such as NO3 if available are readily transported from the root zone to the water table several methods of estimating NO3 loading of the recharge flux are examined. If NO3 load available for transport is associated with only that mobile portion of the recharge which reaches the water table (rather than being distributed evenly throughout the water that has infiltrated the soil profile) high concentrations of NO3 in the recharge flux pulses could be expected. Groundwater pollution may pose a hazard to human health by contamination of drinking water

sources such as wells and springs. Based on preselected safety criteria, as well as flow and transport history of the area, probability isopleths of exceeding a health hazard threshold can be computed and mapped in the potential impact zones. Along with the probability of exceeding the threshold level, associated probabilities of a false positive and a false negative assessment can be estimated. (See also W90-08822) (Lantz-PTT)
W90-08889

ARSENIC CONTAMINATION OF AQUIFERS CAUSED BY IRRIGATION WITH DILUTED GEOTHERMAL WATER.
Montana Bureau of Mines and Geology, Butte.
J. L. Sonderegger, B. R. Sholes, and T. Ohguchi.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 685-694, 3 fig, 2 tab, 4 ref.

Descriptors: *Arsenic, *Geothermal water, *Groundwater pollution, *Headwaters hydrology, *Irrigation water, *Path of pollutants, *Water pollution sources, Alluvial aquifers, Groundwater recharge, Madison River, Public health.

The Madison River has its headwaters in Yellowstone National Park. River water leaving the Park typically contains 200 micrograms/L dissolved arsenic. Downstream dilution normally reduces this to 40-80 micrograms/L in the lower valley (0-25 miles above the river mouth). Extensive use of the river water, via ditch systems, for irrigation of the valley bottom has been ongoing for the past 100 years. Sprinkler irrigation systems have become more popular over the last 20-30 years; sidehills and benches underlain by Tertiary-age sediments have also undergone irrigation. Arsenic concentrations of 80-130 micrograms/L were found in the alluvial aquifer during limited sampling in the mid-1980's. The current study is based upon sampling roughly 75% of the wells in the lower valley, combined with river sampling above and below the major irrigated zone. The major results are: (1) Both the alluvial and underlying Tertiary aquifers have been contaminated. Statistically, the results are almost identical; (2) Substantial increases in surface water dissolved-As content were found below the major irrigation area during freshet and most of the irrigation season; and (3) Commercial reverse osmosis units have been very effective at removing As (efficiencies > 99% are verified) and have resulted in one resident urine-arsenic level decrease of one order of magnitude within six months. (See also W90-08822) (Author's abstract)
W90-08891

BACTERIOLOGICAL QUALITY OF PRIVATE WATER WELLS IN CLARK COUNTY, ARKANSAS.
Henderson State Univ., Arkadelphia, AR. Dept. of Biology.
S. Conine, D. Cox, K. Mitchell, C. Kuyper, and J. Bragg.
Proceedings of the Arkansas Academy of Science AKASAO, Vol. 43, p 19-20, 1989. 1 tab, 5 ref. Henderson State Univ. Faculty Research Grant 512-280.

Descriptors: *Arkansas, *Bacterial analysis, *Drinking water, *Fecal coliforms, *Groundwater quality, *Water pollution sources, *Well water, Ammonia, Coliforms, Farm wastes, Iron, Manganese, Nitrogen, Potable water, Public health, Sulfates.

Fifty wells were sampled during 1987-88 throughout Clark County, Arkansas; an attempt was made to sample wells in each of the approximately 17 geological formations appearing at the surface within the boundaries of the county. Coliform bacteria were isolated from 78% of the wells tested. Since both typical and atypical colonies were enumerated, this parameter was considered to indicate surface water seepage into the well without consideration of fecal contamination. Eighteen percent of the wells tested positive for fecal coliforms and 24% for fecal streptococci. These parameters are indicative of fecal contamination, and the data suggest 18-24% of the wells

have seepage from septic tanks, barnyards, or other sources of animal wastes. An inverse correlation between well depth and degree of bacterial contamination seemed to exist. Deeper wells were less often contaminated by surface seepage. More than 40% of the wells sampled exceeded limitations of iron and manganese, 10% exceeded the limit for ammonia, 8% for nitrate nitrogen, and 6% for sulfate. No correlation between well depth and chemical contaminants was observed, and data are inadequate at this time to relate to particular geologic formations through which the wells pass. Data from the study indicated that most private water wells within Clark County are contaminated with bacteria from surface water. Deeper wells (100 ft or more) are more often free of contamination. Details of construction were not known for most of the wells but deeper wells are usually cased to a greater depth which would prevent surface water seepage into the well. Home owners using an existing shallow well should consider installation of a chlorination system. Inorganic chemicals considered in this study, particularly iron and manganese, may originate from soluble components of the geologic strata through which the well is drilled. Others such as ammonia and nitrate may be of surface origin from fertilizers or from bacterial degradation of contaminating organic compounds. (Brunone-PTT)
W90-08913

SPRINGS OF VIRGINIA REVISITED: A COMPARATIVE ANALYSIS OF THE CURRENT AND HISTORICAL WATER-QUALITY DATA.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Water Resources Research Center.
For primary bibliographic entry see Field 2F.
W90-08918

SELECTIVE OAK REMOVAL DOES NOT HARM WATER QUALITY.
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 4C.
W90-08936

DISTRIBUTION OF CHLORINATED PESTICIDES AND INDIVIDUAL POLYCHLORINATED BIPHENYLS IN BIOTIC AND ABIOTIC COMPARTMENTS OF THE RIO DE LA PLATA, ARGENTINA.
Quebec Univ., Rimouski. Dept. of Oceanography.
J. C. Colombo, M. F. Khalil, M. Arnac, A. C. Horth, and J. A. Catoggio.
Environmental Science and Technology ESTHAG, Vol. 24, No. 4, p 498-505, April 1990. 6 fig, 1 tab, 46 ref.

Descriptors: *Argentina, *Fate of pollutants, *Path of pollutants, *Pesticides, *Water pollution sources, Chemical reactions, Chlorinated hydrocarbons, Estuaries, Nonpoint pollution sources, Polychlorinated biphenyls, Rio de la Plata.

Sources and environmental fate of chlorinated pesticides (CP) and individual polychlorinated biphenyls (PCBs) were investigated in water, sediments, and biota. Dissolved CP and PCB concentrations showed a decreasing trend from the industrialized Rio Santiago (Argentina) to offshore stations. Most polluted sediments showed a large contribution of early-eluting PCBs. In offshore sediments, congeners with four to six chlorines predominated. Organisms presented maximum levels of p,p'-TDE, -DDT, and -DDE, trans-chlordane, and of trichlorobiphenyls to heptachlorobiphenyls, mainly with the 4,4' recalcitrant biosubstitution. Their organochlorine patterns reflected the integration of the signals observed in water and sediments. Lipid-rich organisms showed a lesser degradation of CPs than low-fat fishes and sediments. Except for the less-chlorinated PCBs, which have shorter half lives, water bioaccumulation factors (BAFs) showed a positive correlation with octanol-water partition coefficients (Kow). Sediment BAF-Kow relationships were very complex but could be explained by compound sources, elimination and degradation rates, stereochemistry, and Kows. (Author's abstract)

W90-08941

FLOW CYTOMETRIC DETECTION AND SIZING OF FLUORESCENT PARTICLES DEPOSITED AT A SEWAGE OUTFALL SITE.
Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.
For primary bibliographic entry see Field 5A.
W90-08943

SELF-CLEANING CAPACITY OF SURFACE WATERS AFTER RADIOACTIVE FALLOUT: EVIDENCE FROM EUROPEAN WATERS AFTER CHERNOBYL, 1986-1988.
Texas A and M Univ., Galveston. Center for Marine Resources.
P. H. Santschi, S. Bollhalder, S. Zingg, A. Luck, and K. Farrenkothen.
Environmental Science and Technology ESTHAG, Vol. 24, No. 4, p 519-527, April 1990. 6 fig, 2 tab, 50 ref.

Descriptors: *Chernobyl, *Europe, *Fallout, *Fate of pollutants, *Path of pollutants, *Radioactive wastes, *Self-purification, *Switzerland, Adsorption, Air pollution, Cesium radioisotopes, Desorption, Lake Zurich, Lakes.

Radionuclide fallout from the burning Chernobyl reactor provided a pulsed input of 137Cs to the surface water and watersheds of Europe. Radionuclide analyses of surface waters indicated that initial rates of decrease of 137Cs concentrations in contaminated rivers were on the order of 0.125 per day, which was consistent with the size of the mobile inventory in the watersheds (i.e., approx 1% of the total) and with the initial dilution rate (i.e., approx 0.5/m) in river water. Analysis of 134Cs and 137Cs in waters from five different lakes in Switzerland and of settling particles collected in sediment traps from one of the lakes (Lake Zurich), revealed relatively rapid whole-lake removal rates. Residence times of 137Cs in the five study lakes ranged from 5 to 21 mo. Horizontal boundaries in this lake appeared to have acted first as sinks of Chernobyl 137Cs from the upper water column and later as sources of 137Cs to deeper parts of Lake Zurich. Rates of adsorption/desorption of 137Cs associated with settling particles were found to be small when compared in subsurface waters to those of uptake/release by other processes occurring in the lake. (Author's abstract)
W90-08944

ACIDIFICATION AND RECOVERY OF SPODOSOL BS HORIZON FROM ACIDIC DEPOSITION.
Syracuse Univ., NY. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5C.
W90-08945

PAST ATMOSPHERIC DEPOSITION OF METALS IN NORTHERN INDIANA MEASURED IN A PEAT CORE FROM COWLES BOG.
Indiana Dunes National Lakeshore, Porter, IN.
K. L. Cole, D. R. Engstrom, R. P. Futyma, and R. Stottlemyer.
Environmental Science and Technology ESTHAG, Vol. 24, No. 4, p 543-549, April 1990. 7 fig, 3 tab, 29 ref.

Descriptors: *Fate of pollutants, *Indiana, *Metals, *Monitoring, *Paleolimnology, *Path of pollutants, *Wetlands, Air pollution, Aluminum, Cadmium, Chromium, Cobalt, Copper, Cores, Fens, Iron, Lead, Manganese, Nickel, Radioactive dating, Strontium, Zinc.

A peat core from a calcareous fen was used to assess past metal accumulation from atmospheric sources in northern Indiana. Total concentrations of Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Sr, and Zn were measured at intervals along the core, which were dated by 210Pb, radiocarbon, and pollen analysis. The deposition of airborne metal particulates rose dramatically from presettlement levels as industrialization occurred upwind, with accumula-

tion rates for some metals increasing by two orders of magnitude. Recent accumulation rates are about half of the 1970s, presumably because of emission controls and reduced production. The present results, the first from a calcareous fen, probably were less affected by postdepositional mobility than records from acidic peatlands. This method of retrospective, long-term monitoring of airborne particulates can be applied to areas lacking such records. (Author's abstract)
W90-08946

OCCURRENCE AND FATE OF ORGANIC SOLVENT RESIDUES IN ANOXIC GROUNDWATER AT THE GLOUCESTER LANDFILL, CANADA.
National Water Research Inst., Burlington (Ontario).
S. Lesage, R. E. Jackson, M. W. Priddle, and P. G. Riemann.
Environmental Science and Technology ESTHAG, Vol. 24, No. 4, p 559-566, April 1990. 7 fig, 4 tab, 45 ref.

Descriptors: *Fate of pollutants, *Groundwater pollution, *Landfills, *Ontario, *Organic compounds, *Path of pollutants, Aquifers, Chlorinated hydrocarbons, Dioxins, Freon, Furans, Gas chromatography, Gloucester Landfill, Mass spectrometry, Monitoring.

The disposal of organic chemicals in trenches at a waste disposal site near Ottawa, Ontario, Canada, has resulted in contamination of the underlying aquifer. Groundwater samples from monitoring wells and multilevel samplers were analyzed by gas chromatography-mass spectrometry. Ultratrace quantities of chlorinated dibenzodioxins and furans were found in groundwaters directly beneath the trenches. A wide variety of volatile compounds was identified and quantified in samples from the aquifer. The aliphatic ethers are very mobile, as is chloride; however, because it is also toxic and persistent, 1,4-dioxane is the contaminant of greatest concern in groundwater. The chlorinated aliphatics showed evidence of an in situ transformation with the detection of several lesser chlorinated aliphatics such as chloroethene and 1,1-dichloroethene. The organic chemical found in greatest concentration was the Freon F113. Although obviously very persistent in the subsurface, it, too, appeared to have undergone transformation as one defluorinated and two dechlorinated products, one of which is known to be toxic (F-113), were identified. (Rochester-PTT)
W90-08947

LONGITUDINAL STUDY OF RAINFALL AND COLIFORM CONTAMINATION IN SMALL COMMUNITY DRINKING WATER SUPPLIES.
Dartmouth Medical School, Hanover, NH. Dept. of Microbiology.
T. A. Stukel, E. R. Greenberg, B. J. Dain, F. C. Reed, and N. J. Jacobs.
Environmental Science and Technology ESTHAG, Vol. 24, No. 4, p 571-575, April 1990. 3 fig, 3 tab, 23 ref. EPA Cooperative Agreement CR-810805.

Descriptors: *Coliforms, *Drinking water, *New England, *Path of pollutants, *Rural areas, Public health, Statistics, Time series analysis.

The association between total coliform contamination and rainfall was investigated in 15 small community drinking water systems in rural New England. Water samples were collected and analyzed for total coliform bacteria every week for 1 yr; daily rainfall measurements were obtained from government-monitored weather stations near each system. Statistical methodology for repeated binary responses were employed in data analysis. The odds of total coliform positivity increased by 2.6 (95% confidence interval 1.1-6.1) for every inch of rainfall in the 2 days prior to sampling and by 2.0 (1.03-3.8) per inch of rainfall in the 4 days prior to sampling, adjusted for autocorrelation in the weekly responses. The odds of coliform positivity in any week were 6.0 times higher (95% confidence interval 2.1-16.7) if the previous week's sample was positive. The statistical approach to

analyzing these time series data appears promising for other longitudinal studies of environmental contamination. (Author's abstract)
W90-08948

REMOVAL AND RECOVERY OF BERYLLIUM IN WATERS BY CHLORELLA VULGARIS.
New Mexico State Univ., Las Cruces. Dept. of Chemistry
For primary bibliographic entry see Field 5D.
W90-08960

EFFECT OF SADDAM DAM ON TIGRIS RIVER WATER QUALITY.
M. A. Al-Layla, S. N. Kharrufa, and S. M. Akrawi.
Journal of Environmental Science and Health (A) JESEDU, Vol. 25, No. 1, p 47-66, January 1990. 6 fig, 1 tab, 14 ref.

Descriptors: *Dam effects, *Iraq, *Reservoirs, *Tigris River, *Water quality, Alkalinity, Climates, Dissolved oxygen, Geohydrology, Hardness, Hydrogen ion concentration, Monitoring, Nitrates, Saddam Dam, Sulfates, Sulfur springs, Water quality control.

Monitoring was conducted on the reservoir of Saddam Dam on the Tigris River (Iraq). Water samples were obtained approximately every month from August 1986 through July 1987. The reservoir was filled to capacity during the first half of 1987. Water quality monitoring during this period led to the following observations: (1) dissolved oxygen variation was related to climatic conditions; (2) P concentrations were high and varied according to biological activity; (3) nitrate concentration fluctuated randomly between 0.49 and 1.0 mg/L, indicating the possibility for rapid lake maturation; (4) water impoundment and salt dissolution from geological formations led to high pH values; (5) total alkalinity generally was high due to geologic influence; (6) total hardness was very high due to local geology and the effects of impoundment; (7) variations in sulfate concentration were related to the presence of sulfur springs and dissolution of gypsum and calcareous rocks; and (8) salinity and chloride concentrations were related to climatic conditions and rainy seasons. It is concluded that the lake water is suitable for human consumption, agricultural use, and swimming and other recreation. A lake management program is recommended to avoid eutrophication, control fertilizer inputs, and continue water quality monitoring. (Rochester-PTT)
W90-08962

EFFECT OF INDIGENOUS BACTERIA ON VIRUS SURVIVAL IN GROUND WATER.
Arizona Univ., Tucson. Dept. of Microbiology and Immunology.
M. V. Yates, L. D. Stetzenbach, C. P. Gerba, and N. A. Sinclair.
Journal of Environmental Science and Health (A) JESEDU, Vol. 25, No. 1, p 81-100, January 1990. 2 fig, 5 tab, 31 ref. EPA Contract CR-811147.

Descriptors: *Bacteria, *Groundwater pollution, *Human diseases, *Viruses, Bacteriophage, Poliovirus, Public health, Survival.

Over half the waterborne disease outbreaks in the United States are due to the consumption of contaminated groundwater. Although viruses are a major cause of illness in these outbreaks, very little is known about the factors that influence how long viruses can remain infective in groundwater. Experiments were conducted using several groundwater samples obtained from drinking water wells to determine the effects of the naturally-occurring bacteria on the survival of coliphage MS-2 and poliovirus type 1 inoculated into the samples. The numbers of bacteria and viruses were monitored over a 30-day period. Parallel experiments were conducted using water that had been filtered to remove bacteria. The increase in bacterial numbers in the first 24 hr of incubation was correlated significantly with the decay rate of coliphage MS-2. However, consistent trends were found in the

ability of viruses to persist in the presence or absence of bacteria. (Author's abstract)
W90-08964

WATER QUALITY IN SOUTHEASTERN MINNESOTA STREAMS: OBSERVATIONS ALONG A GRADIENT OF LAND USE AND GEOLOGY.
Minnesota Univ., St. Paul. Dept. of Forest Resources.
For primary bibliographic entry see Field 4C.
W90-08970

LANDSCAPE ASSESSMENT OF SOIL EROSION AND NONPOINT SOURCE POLLUTION.
Minnesota Univ., St. Paul. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2J.
W90-08972

RESIDENCE TIMES OF MINNESOTA GROUNDWATERS.
For primary bibliographic entry see Field 2F.
W90-08976

NITROGEN MANAGEMENT RELATED TO GROUNDWATER QUALITY IN MINNESOTA.
Minnesota Univ., St. Paul. Dept. of Soil Science.
For primary bibliographic entry see Field 5G.
W90-08977

VIRUSES AND DRUG RESISTANT BACTERIA IN GROUNDWATER OF SOUTHEASTERN MINNESOTA.
S. M. Goyal, DA. Amundson, R. A. Robinson, and C. P. Gerba.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 58-62, Fall 1989. 3 fig, 2 tab, 25 ref.

Descriptors: *Bacteria, *Coliforms, *Groundwater pollution, *Karst hydrology, *Minnesota, *Path of pollutants, *Pathogenic bacteria, *Viruses, *Well water, Human pathogens, Karst, Public health, Rural areas, Sewage bacteria.

The karst topography of soils in southeastern Minnesota is responsible for the formation of sinkholes, subsurface cracks, and underground rivers which may enhance the transportation of surface contaminants into groundwater. Private rural wells were sampled to determine the presence of human pathogenic viruses, coliforms, fecal coliforms and coliphages. The occurrence of drug resistance in bacteria isolated from groundwater also was studied. Coliform bacteria were detected at least once from 22 of the 26 sites sampled over 34 months. Water from ten sites yielded drug-resistant indicator bacteria; 25 of 38 (65.8 percent) total coliforms and 9 of 27 (33.3 percent) fecal coliforms tested were found to carry drug resistance. Human enteric viruses were detected by DNA hybridization and/or virus isolation techniques in nine samples from seven different sites, some in the absence of fecal coliforms. Of the 161 samples tested for coliphages, 13 samples from seven sites were found positive. On two occasions, coliphages were isolated from samples in which coliforms were absent. These findings indicate that potential public health problems exist in this region. (Author's abstract))
W90-08978

SUSCEPTIBILITY OF NORTHERN MINNESOTA LAKES TO ACID DEPOSITION IMPACTS.
C. J. Twaroski, J. D. Thornton, R. L. Strassman, and P. L. Brezonik.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 95-102, Fall 1989. 7 fig, 35 ref.

Descriptors: *Acid rain, *Acid rain effects, *Lake acidification, *Minnesota, *Water pollution sources, Chemical reactions, Lake morphology, Model studies.

Lake chemistry surveys indicate a large number of lakes with acid neutralizing capability (ANC)

below 200 microeq/L occur in northeast Minnesota where shallow soils over bedrock and exposed rock outcrops predominate, and in moraine areas having rolling to steep topography in north-central and east-central Minnesota. In the Boundary Waters area, lake chemistry is strongly associated with bedrock geology. Lakes with ANC<100 microeq/L are associated with granite, basalt, and gabbro formations, while lakes with ANC of 100-200 microeq/L are associated with slate and greenstone formations. In the rest of the state where soils are deep, landform, soil type, and lake hydrology determine lake chemistry. Most low ANC lakes are found in terminal moraine areas. These lakes are generally small, have limited groundwater inflow, and are typically classed as precipitation-dominated seepage lakes. Higher ANC lakes (>400 microeq/L) are often associated with agricultural and residential land uses. Relationships found between ANC and bedrock geology, and between ANC and landform and soils, provided the basis for mapping the distribution of low ANC surface waters in Minnesota. Empirical and process models used to evaluate the actual susceptibility of low ANC lakes in the Upper Midwest to acid deposition impacts indicated a precipitation pH of 4.6-4.7 is a threshold level for lake acidification. Modeling also indicated that lakes with ANC <50 microeq/L are very susceptible to acidic inputs and are considered critically sensitive. At present, no culturally acidified lakes have been found in northeast Minnesota, although acid lakes have been found Wisconsin and the Upper Peninsula of Michigan. The Hovland-Grand Marais-Isabella area of northeast Minnesota currently receives precipitation with an annual average pH of 4.7. This area is considered to be on the edge of the 'effects' area and is a major focus of the Minnesota Pollution Control Agency's long-term research and monitoring program on lake and stream response to annual and episodic inputs of acids. (Author's abstract)
W90-08984

MERCURY IN FISH FROM NORTHEASTERN MINNESOTA LAKES: HISTORICAL TRENDS, ENVIRONMENTAL CORRELATES, AND POTENTIAL SOURCES.
E. B. Swain, and D. D. Helwig.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 103-109, Fall 1989. 4 fig, 1 tab, 55 ref.

Descriptors: *Air pollution effects, *Lake fisheries, *Mercury, *Methylmercury, *Water chemistry, *Water pollution sources, Bioaccumulation, Lake sediments.

High mercury concentrations in fish of some Minnesota lakes and rivers were first noted in 1971. Major anthropogenic sources of mercury to Minnesota rivers generally have been identified and controlled, but it has been difficult to identify mercury sources to remote northeastern Minnesota lakes containing fish with elevated mercury levels. Analysis of sediments from these lakes suggests that mercury deposition has increased by a factor of about 3.5 since white settlement in the state. Because the increase is spatially constant across northeastern Minnesota, atmospheric pollution appears to be responsible for the increase. Given that fish mercury varies considerably among lakes, local environmental processes apparently control the conversion of inorganic mercury into the methylmercury found in fish. Mercury levels in Minnesota fish are related to water chemistry, which in turn is influenced by watershed geology. Fish from lakes in limestone-rich watersheds are less likely to have high mercury levels than lakes in low-alkalinity regions. Lakes with colored water are more likely to contain fish with high mercury levels. Trend analysis shows that mercury levels in fish increased significantly between the 1930s and 1980s (comparison between museum specimens and recent samples) and between the 1970s and 1980s. Rates of increase are highest in low-alkalinity lakes. (Author's abstract)
W90-08985

FISHERIES AND ENVIRONMENTAL RESEARCH BY THE MINNESOTA SEA GRANT COLLEGE PROGRAM.

Minnesota Univ., St. Paul. Sea Grant Program.
For primary bibliographic entry see Field 8I.
W90-08986

LAND USE CHANGES AND INPUTS OF NITROGEN TO LOCH LEVEN, SCOTLAND: A DESK STUDY.
Edinburgh School of Agriculture (Scotland).
For primary bibliographic entry see Field 4C.
W90-09014

EXAMINATION OF MODEL ADEQUACY AND ANALYSIS OF PHOSPHORUS DYNAMICS IN LAKE KUORTANEENJARVI: A CASE STUDY WITH TWO LAKE MODELS.
Helsinki Univ. of Technology, Espoo (Finland). Lab. of Hydrology and Water Resources Engineering.
J. Kettunen, A. V. Leonov, and O. Varis.
Publications of the Water and Environment Research Institute PWEIET, No. 3, p 48-54, 1989. 3 fig, 1 tab, 10 ref.

Descriptors: *Algae, *Cycling nutrients, *Eutrophication, *Finland, *Limnology, *Model studies, *Phosphorus, Hungary, Ivankovskoe Reservoir, Lake Balaton, Lake Kuortaneenjarvi, Organic matter, Performance evaluation, Sedimentation, Soviet Union.

The dynamics of P and algae in Lake Kuortaneenjarvi, Finland, were studied. Two mathematical models were used to analyze the lake behavior. One was emphasizes analysis of algal dynamics, whereas the other focuses on P transformations and was transferred with a slight recalibration from Lake Balaton, Hungary and Ivankovskoe Reservoir, USSR. The adequacy of complex ecological lake models in the case of inadequate field data also was examined. The results showed that incoming P fractions differed greatly between the two basins of the lake. Organic fractions were more dominating in the lower basin. Net sedimentation was only 20% of the gross sedimentation. The calibration results of the two models were quite adequate as far as the observed variables were considered, but the overparameterization of the models demonstrated inadequacies of unobserved items. Both models suffer from overparameterization, i.e., they contain an excessive degree of freedom compared with the observations available. This is a general drawback of the approach. The modeling approach can be applied for various purposes of lake ecosystem analysis as far as observed variables are concerned. Although the models were not considered adequate for the non-observed variables, the order of magnitude was about right, suggesting that the results should be considered as providing a framework. (Rochester-PTT)
W90-09032

SEDIMENTATION DYNAMICS IN THE SANTA MONICA-SAN PEDRO BASIN OFF LOS ANGELES: RADIOCHEMICAL, SEDIMENT TRAP AND TRANSMISSOMETER STUDIES.
Oregon State Univ., Corvallis. Coll. of Oceanography.
For primary bibliographic entry see Field 2J.
W90-09035

FATE OF PETROLEUM HYDROCARBONS AND TOXIC ORGANICS IN LOUISIANA COASTAL ENVIRONMENTS.
Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments.
R. D. DeLaune, R. P. Gambrell, J. H. Pardue, and W. H. Patrick.
Estuaries ESTUDO, Vol. 13, No. 1, p 72-80, March 1990. 7 fig, 4 tab, 23 ref.

Descriptors: *Bottom sediments, *Chemical degradation, *Chemical wastes, *Coastal waters, *Estuaries, *Fate of pollutants, *Herbicides, *Hydrocarbons, *Organic pollutants, *Path of pollutants, *Pesticides, *Reviews, DDT, Louisiana, Polychlorinated biphenyls.

Numerous potentially toxic compounds are entering Louisiana's inshore and nearshore coastal environments, including herbicides, pesticides, and compounds associated with petroleum exploration and the refining and chemical manufacturing industries. To a large degree there is insufficient information for predicting the fate and effect of these materials in aquatic environments. Laboratory studies using sediments from Louisiana coastal wetlands have demonstrated the importance of pH and redox potential in governing the degradation rate of a variety of compounds entering Louisiana coastal wetlands, including petroleum hydrocarbons, pesticides and herbicides, and chlorinated industrial organics. Sediment pH and redox conditions have been found to play an important role in the microbial degradation of toxic organics. Most of the hydrocarbons investigated degrade more rapidly under high redox (aerobic) conditions, although there are exceptions (e.g., 1,1,1-trichloro-2,2-bis(4-chlorophenyl)(DDT) and polychlorobiphenyls (PCBs)). There are conflicting reports on the ecological impact of toxic organics in Louisiana coastal areas. Some studies indicate that the salt marshes have a low sensitivity to oil. Some of these compounds, due to their slow degradation in anaerobic sediment, may persist in the system for decades. Additional work is required to understand the degradation, toxicology, and transport of these compounds in the coastal environments. Of particular interest is whether or not the bottom sediments are a sink for these compounds or if they will be a large source of contamination in the future. (Author's abstract)
W90-09045

LABORATORY SIMULATION OF DIFFUSION IN CONTAMINATED MARINE SEDIMENTS.
Louisiana State Univ., Baton Rouge. Dept. of Chemical Engineering.
J. A. Baron, L. J. Thibodeaux, D. D. Rieble, P. H. Templet, and C. B. Henry.
Estuaries ESTUDO, Vol. 13, No. 1, p 81-88, March 1990. 7 fig, 1 tab, 17 ref. Center for Energy Studies Grant No. 86-02-07.

Descriptors: *Diffusion, *Mathematical models, *Path of pollutants, *Sorption, Chemical properties, Drilling fluids, Environmental tracers, Marine sediments.

Wastes from offshore oil drilling activities are often discharged to the marine environment. Solid wastes that settle onto the bottom sediment may pose a health threat to marine organisms and eventually to man through the food chain. An understanding of their fate is critical for predicting the chemical concentration levels and life-times in the sediment and adjoining aquatic boundary layer. Many processes may govern the fate of these contaminants, including biodegradation, transport by currents, bioturbation, and diffusion. The effect of diffusion is considered a conservative estimate of the time required to transport the contaminants back to the water column, in that other biotic and abiotic processes will result in more rapid contaminant movement. Comparing the results of a transport model and laboratory simulation of selected in-bed processes governing contaminant leaching from the sediment, utilizing naphthalene and p-dichlorobenzene as tracer compounds, indicate that the model and simulations are appropriate for estimating chemical flux rates from sediment beds in the marine environment. The process chosen for simulation in this study is the coupled desorption-diffusion of contaminants from the bed to the water column. The results suggest that the experimental procedure represents a good way of estimating the diffusive leaching rates of hydrophobic compounds from contaminated sediments. (Author's abstract)
W90-09046

PETROLEUM DRILLING AND PRODUCTION OPERATIONS IN THE GULF OF MEXICO.
University of Southwestern Louisiana, Lafayette. Dept. of Chemical Engineering.
C. S. Fang.
Estuaries ESTUDO, Vol. 13, No. 1, p 89-97, March 1990. 1 fig, 7 tab, 25 ref.

Descriptors: *Drilling, *Drilling fluids, *Fate of pollutants, *Gulf of Mexico, *Hydrocarbons, *Oil industry.

Decades of offshore and inland petroleum drilling and production in the Gulf of Mexico and on the Gulf Coast have provided the much needed energy and chemical feedstocks to the nation, and have also made an impact on the environment in the area. As a result of drilling operations, however, deposits of contaminated sediment are found on the ocean floor around offshore platforms and old reserve pits, and dump sites next to many surface facilities and compressor stations. The substances found on the ocean floor and in dump sites are simple or emulsified mixtures of silt, hydrocarbons, and water. The cleaning of the ocean floor and pits is an economic and technical challenge. Hydrocarbons are from crude oil and chemical additions for various operational necessities, including biocides, corrosion inhibitors, antifreezes, and coagulants. The largest discharge by volume from an offshore platform is produced water, which commonly contains several compounds found on the Priority Pollutant List. Some studies have identified as many as 115 substances in produced water. There is a substantial amount of oil and barium-enriched sediments associated with the drilling platforms in the Gulf of Mexico. When the new government regulations lower the allowable maximum total organic carbon level to the 50 mg/L range, these hydrocarbons can no longer be ignored by drilling and production operators. (Author's abstract)
W90-09047

CONTAMINANTS IN SEDIMENTS FROM THE CENTRAL GULF OF MEXICO.
Gulf Coast Research Lab., Ocean Springs, MS.
T. F. Lytle, and J. S. Lytle.
Estuaries ESTUDO, Vol. 13, No. 1, p 90-111, March 1990. 13 fig, 3 tab, 26 ref. NOAA Office of Sea Grants NA79AA-D-00049, NA80AA-D-00017, and NA81AA-D-00050.

Descriptors: *Hydrocarbons, *Marine sediments, *Organic carbon, *Organic pollutants, *Path of pollutants, *Sediment contamination, *Water pollution sources, Gulf of Mexico, Mississippi Sound, Nitrogen compounds, Phenols.

Mississippi Sound is a shallow embayment that includes small bays, marshes, bayous, and rivers along the northern shore and is bounded by a chain of offshore islands on the south. Surface sediment samples at 89 locations and 300-cm cores from 43 sites in the Mississippi Sound were examined for evidence of pollutant impact upon this coastal environment. Preference was given to sediments as a sampling medium because of their tenacity for pollutants, their capacity to retain pollutants in a locale for long periods of time, their preservation of the pollution history of an area, and for their potential toxicity over extended intervals of time. Chemical variables determined were total organic carbon, Kjeldahl nitrogen, phenols, and hydrocarbons. Values of these pollutant indicators were about the same or lower in Gulf of Mexico samples compared to Mississippi Sound sediments, and considerably lower than those from rivers and bays emptying into the sound, indicating limited impact from sites of pollutant sources into the sound. Concentrations of sedimentary pollutants peaked in the Pascagoula River where levels of total organic carbon (TOC), Kjeldahl nitrogen (TKN), phenols, and hydrocarbons exceeded sound values by one to three orders of magnitude. Analysis of cores showed pollutant intrusion to sediment strata predating industrial development. The level of pollution varies from site to site but fortunately is only serious at localized sites within the sound. (Author's abstract)
W90-09048

INTERACTION OF TRACE METALS WITH NATURAL PARTICLE SURFACES: COMPARISON BETWEEN ADSORPTION EXPERIMENTS AND FIELD MEASUREMENTS.
Eidgenoessische Technische Hochschule, Zurich (Switzerland).
B. Muller, and L. Sigg.
Aquatic Sciences AQSCEA, Vol. 52, No. 1, p 75-92, 1990. 4 fig, 2 tab, 27 ref.

Descriptors: *Adsorption, *Particulate matter, *Path of pollutants, *Trace metals, *Water chemistry, Field tests, Ions, Lead, Mathematical equations, Metal complexes, Model studies, River systems, Rivers, Switzerland, Voltammetry, Water sampling, Zinc.

The distribution of the metal ions Zn and Pb between particulate and dissolved phase in the Glatt River was studied by field measurements and compared with calculated simulations, using parameters obtained by adsorption experiments with natural suspended particulate material. Differences in distribution coefficients obtained from field data are observed as a function of the sampling locations and of the composition of the particulate matter. Experiments in which metal ion solutions are titrated with a suspension of natural particles and analyzed by anodic stripping voltammetry, are interpreted in terms of binding capacities and conditional stability constants of Zn and Pb with the surface sites. Binding constants of a particular metal ion varied very little for all samples. Organic material, iron and manganese oxides are considered to be the main components that control the adsorption to the particles. Distribution coefficients are calculated from the experimentally obtained binding capacities and conditional stability constants. Calculated distribution coefficients for Zn agree with those obtained from the field data and are not very sensitive to changes in the composition of the solution. Good agreement was obtained for lead as well; for some samples it was important to take two types of sites with different affinity into consideration. (Author's abstract)
W90-09052

RADIONUCLIDES IN EFFLUENT FROM COAL MINES, A COAL-FIRED POWER PLANT, AND A PHOSPHATE PROCESSING PLANT IN ZASAVJE, SLOVENIA (YUGOSLAVIA).
Institut Jozef Stefan, Ljubljana (Yugoslavia).
I. Kobal, D. Brajnik, F. Kaluza, and M. Vengust.
Health Physics HLTPAO, Vol. 58, No. 1, p 81-85, January 1990. 3 fig, 3 tab, 30 ref.

Descriptors: *Chemical industry, *Coal mines, *Industrial plants, *Path of pollutants, *Radioactive wastes, *Stream pollution, *Thermal powerplants, *Water pollution sources, Fly ash, Impaired water quality, Mine drainage, Phosphates, River systems, Water analysis, Water pollution control, Water sampling, Yugoslavia.

Radium-226 was sampled along the Sava River and the Boben stream to monitor environmental pollution. The coal mines, coal separation utilities, a coal-fired power plant, and fly-ash pile had no detectable radiological impact on the aquatic system. On the other hand, the phosphate industry has enhanced the radioactivity of the small stream in which waste waters and sludges are released, leading to contamination of the Sava River. There is probably no need for alarm, but occasional surveys of the water around the plant would be advisable, especially in cases when phosphate ore with supposedly high radium content is to be processed. (Creskoff-PTT)
W90-09054

AMMONIA NITROGEN IN THE BLACK SEA (IN RUSSIAN).
V. V. Sapozhnikov.
Okeanologiia OKNOAR, Vol. 30, No. 1, p 53-58, 1990. 4 fig, 8 ref. English summary.

Descriptors: *Ammonia, *Black Sea, *Nitrogen, *Nutrients, *Path of pollutants, *Water chemistry, Danube River, Data collections, Deep water, Profiles, Shallow water, Spatial distribution, Vertical distribution.

All information on ammonia-nitrogen determination in the Black Sea was summarized for the first time. Using these data, the spatial distribution and vertical structure of this most unstable form of nitrogen were investigated. The typical vertical

profile of ammonia-N concentration had minima at 10-30 m and 70-100 m and increased toward the bottom to up to 100 microM. This pattern occurred in all deep parts of the sea. High concentrations of ammonia-N were also found in shallow zones, especially near the Danube Delta. (Author's abstract)
W90-09060

GROUND WATER CONTAMINATION: SOURCES, EFFECTS AND OPTIONS TO DEAL WITH THE PROBLEM.
The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). 453 p. Edited by Pete Churchill and Ruth Patrick.

Descriptors: *Conferences, *Groundwater management, *Groundwater pollution, *Groundwater quality, *Water pollution control, *Water pollution effects, Aquifers, Classification, Environmental effects, Management planning, Policy making, Public health, Regulations, Risk assessment, Site remediation.

Groundwater contamination is a serious problem throughout the United States. To correctly manage groundwater, it is necessary to acquire many facts about the ment of contaminants; effects of contaminants on the environment and human health; and remedial methods and options. There is a need to understand what risks to human health and the environment are present in the effects of various contaminants. Management options or strategies to control contamination must be developed. The policies for managing groundwater vary greatly from state-to-state. The major categories of policy among the states are non-degradation, limited degradation, and differential protection. Various state strategies include one or a combination of the following components: (1) aquifer classification; (2) contamination and source classification; (3) uniform management; and (4) recharge zone protection. These proceedings address groundwater contamination management and treatment through discussions which fall into six panels: (1) Contamination vs. health effects--which should be the basis for action; (2) What happens to contaminants and how good are our prediction tools; (3) How clean is clean--what is the basis for determining cleanliness; (4) Remedial technology to mitigate contamination; (5) Whether there should be a classification system--if so, what is the basis for the system; and (6) Options for preventing contamination. (W90-09064 thru W90-09087)(Fish-PTT)
W90-09063

HYDROLOGY OF FINE-GRAINED MATERIALS.
For primary bibliographic entry see Field 2F.
W90-09068

BIOTRANSFORMATION OF CONTAMINANTS IN GROUND WATER.
For primary bibliographic entry see Field 2F.
W90-09069

HOW CLEAN IS CLEAN GROUND WATER REMEDIATED BY IN SITU BIORESTORATION.
For primary bibliographic entry see Field 5G.
W90-09072

BIODEGRADATION OF GROUND WATER POLLUTANTS WHEN OXYGEN IS UNAVAILABLE.
J. M. Suflita.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 271-294, 6 fig, 3 tab, 14 ref. EPA Agreements CR-812808 and CR-813559.

Descriptors: *Biodegradation, *Bioremediation, *Fate of pollutants, *Groundwater pollution, An-

aerobic conditions, Aquifers, Biotransformation, Chemical reactions, Groundwater quality, Halogenated hydrocarbons, Methanogenesis, Organic pollutants, Sulfates.

In recent years, information has steadily emerged on the fate and kinetics of pollutant decomposition in subsurface environments. However, many aquifers can be devoid of oxygen, especially when impacted by degradable organic matter. Comparatively little work has been devoted toward a fundamental understanding of cycling of natural and xenobiotic forms of carbon in anaerobic subsurface environments. Several investigations were performed on the fate of halogenated and alkylated aromatic compounds in samples obtained from two sites within a shallow anoxic aquifer. Carbon and electron flow was primarily through methanogenesis at one site, whereas sulfate-reduction predominated at another. This realization provided an opportunity to study pollutant decomposition under these different conditions. The anaerobic decomposition of halogenated aromatic substrates was preceded by the initial removal of aryl halides under methanogenic conditions. However, the anaerobic metabolism of alkylated aromatic compounds proceeded via methyl hydroxylation reactions. Cresol decomposition was clearly favored under sulfate-reducing conditions, but sulfate inhibited aryl reductive dehalogenation reactions. These results illustrate that various pollutants can exhibit significant biodegradation under appropriate reducing conditions, and demonstrate that much information is needed on the controlling environmental variables in order to predict in what cases such biotransformations will be observed. (See also W90-09063) (Fish-PTT)
W90-09076

IMPACT OF PRECIPITATION VARIABILITY ON THE QUALITY OF RUNNING WATERS.
Uppsala Univ. (Sweden). Dept. of Hydrology.
A. Simeonidis.
IN: Conference on Climate and Water. Volume 2. September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. p 28-36, 8 fig, 4 ref.

Descriptors: *Aquatic environment, *Climatic changes, *Precipitation, *Precipitation variability, *River basins, *Solute transport, *Sweden, *Water pollution sources, *Water quality, Catchment areas, Chemical oxygen demand, Fyris River, Nitrogen, Organic matter, Phosphorus.

Physico-chemical data obtained for the period 1965-1986 have been used to investigate time variations of substances transported in the Fyris River within Uppsala County, Sweden. Substance transports have been calculated for phosphorus, nitrogen, and organic matter measured as chemical oxygen demand (COD-Mn). The yearly substance transport series shows a significant change about the year 1976. After this year the transport increases for all three elements, having decreased since 1967. The substance transport series closely follows the precipitation variability as shown in the yearly precipitation sums. The precipitation data were from a station within the Fyris River drainage basin. Average yearly concentrations were investigated for each element. Nitrogen concentrations increased steadily until 1976 while phosphorus and COD-Mn decreased during the same period. After this year changes in concentrations were only moderate. It is concluded that the increase of the elements after 1976 is due to increase in precipitation amounts. (See also W90-09088) (Author's abstract)
W90-09090

NON-POINT SOURCE POLLUTION FROM IRRIGATED WATERSHEDS: AN ASSESSMENT AND MANAGEMENT WITH REGARD TO CLIMATIC CHANGES.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2A.
W90-09096

CHEMICAL COMPOSITION OF INTERCEPTED CLOUDWATER IN THE SIERRA NEVADA.

California Inst. of Tech., Pasadena. W.M. Keck Lab. of Environmental Engineering Science.
J. L. Collett, B. C. Daube, and M. R. Hoffmann.
Atmospheric Environment ATENBP, Vol. 24A, No. 4, p 959-972, 1990. 11 fig, 3 tab, 35 ref. California Air Resources Board Contract A6-185-32.

Descriptors: *Acid rain, *Chemistry of precipitation, *Cloud liquid water, *Nitrates, *Path of pollutants, *Sulfates, *Water pollution sources, Acetic acid, Acidic water, Ammonia, Hydrogen ion concentration, National parks.

The chemical composition of cloudwater in the Sierra Nevada is dominated by NO3(-), SO4(--), and NH4(+). Cloudwater pH is determined largely by the balance between the concentrations of these three species, although inputs of formic and acetic acid also believed to be important, particularly when anthropogenic inputs are small. Cloudwater samples collected in Sequoia National Park (SNP) exhibited pH values ranging from 3.9 to 6.5; Yosemite National Park (YNP) cloudwater samples had pH values ranging from 3.8 to 5.2. Samples collected at YNP were more acidic than those collected at SNP. The difference in pH between the two regions appears to be due to relatively small differences in inputs of NO3(-), SO4(--), and NH4(+). In the absence of inputs of NH3, cloudwater pH values in the Sierra may fall below 3. Over 250 hr of cloud interception were observed during a 12 month period at a cloud monitoring site at 1856 m elevation in SNP. Estimates of cloudwater deposition of NO3(-), SO4(--), and NH4(+) indicate that cloud interception contributes significantly to regional acid deposition for closed forest canopies. Cloud interception may be the dominant deposition mechanism for isolated conifers and ridgetop canopies, where wind speeds are higher and cloudy air parcels can impact directly on foliar surfaces. (Author's abstract)
W90-09115

MERCURY CONTENT OF ANTARCTIC SURFACE SNOW: INITIAL RESULTS.
Department of Scientific and Industrial Research, Petone (New Zealand). Chemistry Div.
For primary bibliographic entry see Field 2C.
W90-09116

BEHAVIOR OF HEAVY METALLIC ELEMENTS IN PLANTS: I. THE UPTAKE OF HEAVY METALLIC ELEMENTS BY AQUATIC PLANTS.
Yamagata Univ. (Japan). Dept. of Chemistry.
T. Gotoh, and T. Iriye.
Japanese Journal of Limnology RIZAAU, Vol. 50, No. 4, p 321-331, October 1990. 4 fig, 7 tab, 8 ref. English summary.

Descriptors: *Aquatic plants, *Bioaccumulation, *Heavy metals, *Path of pollutants, Absorption, Cadmium, Chromium, Copper, Iron, Manganese, Water hyacinth, Zinc.

The uptake of heavy metallic elements in aquatic plants was studied in Eichhornia crassipes and Egeria densa. The plants were cultivated for 30 days in culture solution which contained various amounts of the metallic elements Cd, Cr, Cu, Fe, Mn, and Zn. The uptake of Cd, Cr, and Cu which occurred in low levels in plants increased with increasing concentrations of metals in culture solution. A similar tendency was observed in the behavior of Zn, but no correlation was observed between the amount of Mn uptake and the concentration of Mn in culture solution. Ferric ions were precipitated as iron (III) hydroxide immediately after the addition. Nevertheless, the plant took in a large amount of ferric ions from culture solution. It seems that a plant has a unique mechanism in regard to the uptake and the discharge of iron. When the culture solution was exchanged every 10 days during the cultivation of Egeria densa, the amounts of uptake of heavy metallic elements, except iron, increased for 30 days. The uptake of iron by the plant decreased temporarily and began to increase when new culture media was introduced. (Author's abstract)

W90-09120

PALEOLIMNOLOGY OF MCNEARNEY LAKE: AN ACIDIC LAKE IN NORTHERN MICHIGAN.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 2H.
W90-09125

METHOD FOR THE EXTRACTION OF CARBONACEOUS PARTICLES FROM LAKE SEDIMENT.
University Coll., London (England). Palaeoecology Research Unit.
For primary bibliographic entry see Field 5A.
W90-09126

INVESTIGATION OF COPPER COMPLEXATION IN THE SEVERN ESTUARY USING DIFFERENTIAL PULSE CATHODIC STRIPPING VOLTAMMETRY.
Water Research Centre, Medmenham (England).
S. C. Apte, M. J. Gardner, and J. E. Ravenscroft.
Marine Chemistry MRCHBD, Vol. 29, No. 1, p 63-75, March 1990. 4 fig, 3 tab, 23 ref.

Descriptors: *Copper, *Estuaries, *Fate of pollutants, *Metal complexes, *Organic matter, *Path of pollutants, *Voltammetry, Dissolved solids, England, Model studies, Pollutant identification, Severn Estuary.

Copper complexation in water samples from the Severn Estuary has been characterized by metal titrations using differential pulse cathodic stripping voltammetry. The titration results were interpreted using a single ligand model of complexation. In all samples, measured ligand concentrations were in excess of dissolved copper and ranged between 13.3 and 196 nanomoles. The range of log conditional stability constants determined was 11.4-12.8. Both ligand concentration and dissolved copper appeared to behave conservatively in the estuary, with the river being the dominant source of both constituents. In all of the samples analyzed, greater than 99% of dissolved copper was organically complexed, with calculated pCu(2+) values ranging from 11.12 to 12.84. The results of this study strongly suggest that copper is transported to the oceans in the form of river-borne organic complexes. (Author's abstract)
W90-09128

NOTE ON THE DISTRIBUTION OF MN, ZN AND CU IN CRABS FROM SEPETIBA BAY (NOTA SOBRE A DISTRIBUICAO DE MN, ZN E CU EM SIRIS DA BAIA DE SEPETIBA).
Universidade Federal Fluminense, Niteroi (Brazil). Dept. de Geoquimica.
L. Drude de Lacerda, C. E. Veiga de Carvalho, and M. Pontes Gomes.
Revista Brasileira de Biologia RBBIAL, Vol. 49, No. 3, p 847-849, August 1989. 1 tab, 11 ref. English summary.

Descriptors: *Brazil, *Copper, *Crabs, *Fate of pollutants, *Heavy metals, *Manganese, *Zinc, Atomic absorption spectrophotometry, Bays, Bioaccumulation, Crustaceans, Exoskeleton, Muscle, Pollutant identification.

The concentrations of Cu, Mn, and Zn in two crab species from Sepetiba Bay were determined by atomic absorption spectrophotometry. Highest concentrations of Zn and Cu were found in the viscera and muscle, while the highest Mn concentrations were found in the exoskeleton. The results indicate that Zn concentrations already surpassed the maximum level metabolically controlled by these animals. (Author's abstract)
W90-09131

STUDY OF ACID MINE DRAINAGE USING EARTH RESISTIVITY MEASUREMENTS.
Indiana Univ. at Bloomington. Dept. of Geography.
A. M. Ebraheem, M. W. Hamburger, E. R.

Bayless, and N. C. Krothe.
Ground Water GRWAAP, Vol. 28, No. 3, p 361-368, May/June 1990. 13 fig, 1 tab, 16 ref.

Descriptors: *Conductivity, *Geophysics, *Groundwater pollution, *Leachates, *Mine wastes, *Path of pollutants, *Resistivity surveys, Dissolved solids, Electrodes, Indiana, Mapping, Sounding, Test wells, Waste dumps.

A resistivity survey was conducted in a reclaimed mine spoils disposal site near Wheatland, Indiana to study the groundwater contamination. Due to the high conductivity of the acidic leachate from coal refuse, it was possible to detect the valleys in which this material was dumped (gob valleys) by using the horizontal resistivity profiling technique. The thickness of the gob valleys and information about the stratigraphy of the site were obtained by using the vertical electrical sounding (VES) technique. The VES data for sounding points located near monitoring wells, together with the chemical analyses of water samples taken from these wells, were used to obtain an empirical relationship between the inferred earth resistivity and the amount of total dissolved solids (TDS) in the ground water. The horizontal resistivity profiling data and the VES data at a 30-ft electrode spacing were contoured. The resulting isoresistivity map, together with the empirical relationship, can be used to predict the approximate TDS concentration at a depth of approximately 30 ft at any point on the Wheatland site. (Author's abstract)
W90-09136

ESTIMATION OF LEAK RATES FROM UNDERGROUND STORAGE TANKS.
ENSR, Acton, MA.
B. S. Levy, P. J. Riordan, and R. P. Schreiber.
Ground Water GRWAAP, Vol. 28, No. 3, p 378-384, May/June 1990. 7 fig, 3 tab, 11 ref. U.S.EPA Contract 68-03-3409.

Descriptors: *Estimating equations, *Leakage, *Monitoring, *Path of pollutants, *Underground storage tanks, *Water pollution sources, Hydrocarbons, Soil contamination, Test wells.

A methodology for estimating the rate and volume of leakage from an underground storage tank measures the liquid hydrocarbon thickness upon the water table at two or more monitoring wells located at differing distances from the leaking underground storage tank. The methodology uses type-curve fitting. Two solutions are developed: one for the case of a flat, rigid water table, and another for the case of a deflected water table. These solutions provide upper and lower estimates for leak rate and duration. The use of the technique is demonstrated by its application to a field case. The technique is best applied to sites with medium-grained to coarse-grained sands and gravels with minimal capillary effects; application of the technique to sites of fine-grained porous media may produce unreasonable results due to capillarity. (Author's abstract)
W90-09138

CAUSES OF SOIL SALINIZATION: I. A BASIN IN SOUTHERN ALBERTA, CANADA.
Alberta Agriculture, Lethbridge.
For primary bibliographic entry see Field 2K.
W90-09139

GROUND-WATER CONTAMINATION BY HIGH-DENSITY IMMISCIBLE HYDROCARBON SLUGS IN GRAVITY-DRIVEN GRAVEL AQUIFERS.
Washington State Univ., Pullman. Dept. of Civil and Environmental Engineering.
M. Y. Corapcioglu, and M. A. Hossain.
Ground Water GRWAAP, Vol. 28, No. 3, p 403-412, May/June 1990. 8 fig, 3 tab, 25 ref.

Descriptors: *Aquifers, *Chlorinated hydrocarbons, *Groundwater pollution, *Model studies, *Path of pollutants, Leaching, Mathematical models, Numerical analysis, Vertical flow, Viscosity.

In contrast to light hydrocarbons like gasoline that float on the water table, high-density chlorinated hydrocarbons such as TCE and TCA released to the environment sink into the aquifer and remain at the bottom for extended periods of time. The migration of these hydrocarbons is generally governed by the vertical component instead of lateral transport as for low-density hydrocarbons. The Buckley-Leverett approach is extended to a two-dimensional case to simulate the migration of a high-density hydrocarbon displacing groundwater in a highly pervious gravity-driven natural-gradient gravel aquifer. Governing equations are solved by modifying the USGS solute transport model (Konikow and Bredehoeft, 1978). The modification incorporates the fractional flow curves of water and their saturation derivatives in vertical and horizontal directions as functions of degree of water saturation. As an example, a contamination incident representing a TCE spill from a storage tank buried in the saturated zone is considered. Numerical results show that high-density, low-viscosity immiscible chlorinated hydrocarbons can travel deeper and further in contrast to lower-density, higher-viscosity compounds, and that the migration is dominated by gravity-driven vertical flow until the plume reaches the lower boundary. (Author's abstract)
W90-09141

QUANTITATIVE ANALYSIS FOR THE CLEANUP OF HYDROCARBON-CONTAMINATED SOILS BY IN-SITU SOIL VENTING.
Shell Development Co., Houston, TX.
For primary bibliographic entry see Field 5G.
W90-09142

APPARATUS TO DETERMINE THE EFFICIENCY OF TRANSFER OF BACTERIA FROM A BURSTING BUBBLE TO THE JET DROPS.
State Univ. of New York at Albany. Atmospheric Sciences Research Center.
D. C. Blanchard, and L. D. Syzdek.
Limnology and Oceanography LIOCAH, Vol. 35, No. 1, p 136-143, January 1990. 5 fig, 17 ref. NSF Grant ATM 85-14211.

Descriptors: *Bacteria, *Bubbles, *Path of pollutants, Aerosols, Air pollution, Lakes.

An apparatus was developed to determine the efficiency by which bacteria scavenged and attached to a bubble are transferred upon bubble bursting to the jet drops. Experiments were done by letting bubbles of 625-micron diameter rise about 27 cm through a suspension of Serratia marcescens. After passing through the bacterial suspension, the bubble passed through a bubble tube filled with sterile water or water that did not contain the bacterium S. marcescens. The trapped bubble rose to the top where it was removed and plated out to determine the amount of bacteria trapped in it. The transfer efficiency varied between 50 and 100% and was an inverse function of the concentration of bacteria in the water through which the bubbles rose. This research is pertinent to the analysis of aerosols generated from lakes and ocean sprays where bacterial concentrations in films may account for significant transport of these contaminants. (Geiger-PTT)
W90-09148

COMPARISON OF NUMERICAL SCHEMES FOR SOLVING A SPHERICAL PARTICLE DIFFUSION EQUATION.
Environmental Research Lab., Athens, GA.
F. K. Fong, and L. A. Mulkey.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 843-853, May 1990. 8 fig, 3 tab, 26 ref, append.

Descriptors: *Diffusion, *Model studies, *Path of pollutants, *Sediments, *Sorption, Kinetics, Mathematical models, Particle size, Solute transport.

The relevance of sorption in pollutant-sediment interactions is well-known. In view of the complex behavior often displayed in the sorption process, new robust iterative numerical scheme was devel-

oped for a nonlinear diffusive model which described sorption dynamics in spherical particle suspensions. The numerical scheme had been applied to finite difference and finite element models which showed rapid convergence and stability under wide ranges of partition coefficients. Comparisons were made with explicit finite difference and orthogonal collocation methods. The diffusive model assumes complete mixing in the bulk aqueous solution and considers intraaggregate transport within the suspended particles. The effect of particle size distribution of suspensions was also included in the model. Sorption was described using both linear and nonlinear methods. (Cassar-PTT)
W90-09159

QUASI-LINEAR THEORY OF NON-FICKIAN AND FICKIAN SUBSURFACE DISPERSION: I. THEORETICAL ANALYSIS WITH APPLICATION TO ISOTROPIC MEDIA.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
S. P. Neuman, and Y. K. Zhang.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 887-902, May 1990. 14 fig, 1 tab, 42 ref, append. U.S. Nuclear Regulatory Commission Contract NRC-04-86-123, FIN D1672.

Descriptors: *Groundwater movement, *Groundwater pollution, *Hydraulic conductivity, *Path of pollutants, *Porous media, *Solute transport, Dispersion, Ficks Law, Isotropy, Mathematical studies, Plumes.

A theory was developed which accounts for nonlinearity caused by the deviation of plume particles from their mean trajectory in three-dimensional, statistically homogeneous but anisotropic porous media under a exponential covariance of log hydraulic conductivities. According to the quasi-linear theory, the transverse dispersivities ascend to peak values and then diminish gradually toward nonzero Fickian asymptotes which are proportional to the square of the log hydraulic conductivity variance when the log hydraulic conductivity variance is much less than 1. The quasi-linear theory proved less prone to error than linear theories when extended to strongly heterogeneous media. It also predicted that when the log hydraulic conductivity was much greater than 1 in isotropic media both the longitudinal and transverse dispersivities ascend monotonically toward Fickian asymptotes proportional to the log hydraulic conductivity. (See also W90-09164) (Cassar-PTT)
W90-09163

QUASI-LINEAR THEORY OF NON-FICKIAN AND FICKIAN SUBSURFACE DISPERSION: II. APPLICATION TO ANISOTROPIC MEDIA AND THE BORDEN SITE.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
Y. K. Zhang, and S. P. Neuman.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 903-913, May 1990. 13 fig, 20 ref. U.S. Nuclear Regulatory Commission Contract NRC-04-86-123, FIN D1672.

Descriptors: *Groundwater movement, *Groundwater pollution, *Hydraulic conductivity, *Model studies, *Path of pollutants, *Porous media, *Solute transport, Anisotropy, Borden, Dispersion, Ficks Law, Mathematical studies, Ontario, Plumes.

A theory was developed which accounts for nonlinearity caused by the deviation of plume particles from their mean trajectory in three-dimensional, statistically homogeneous but anisotropic porous media under a exponential covariance of log hydraulic conductivities. When this theory was applied to an anisotropic case, it showed that longitudinal and transverse dispersivities became asymptotically proportional to log hydraulic conductivity when the log hydraulic conductivity variance was much smaller than 1. It also implied that when the mean seepage velocity vector is at an angle to the principal axes of statistical anisotropy, the long axis of a plume is generally offset toward the direction of the largest log hydraulic conductivity correlation scale. When the mean seepage velocity vector was 45 degrees to the bedding in strongly

stratified media, the longitudinal axis was nearly parallel to the bedding under non-Fickian conditions. As Fickian conditions were approached, the plume rotated toward the mean seepage velocity vector and stabilized asymptotically at a relatively small angle of deflection depending on the log hydraulic conductivity variance. Application of the quasi-linear theory to depth-averaged concentration data from a tracer experiment (bromide and chloride) at Borden, Ontario, gave a consistent and improved fit to a two-dimensional model without any need for parameter adjustment. In the Borden experiment the longitudinal spread is non-Fickian until about 2.8 years, when it attains an asymptotic value of 0.51. Transverse spread does not become strictly Fickian until 82 years. (See also W90-09163) (Cassar-PTT)
W90-09164

CHARACTERIZATION OF TRANSPORT IN AN ACIDIC AND METAL-RICH MOUNTAIN STREAM BASED ON A LITHIUM TRACER INJECTION AND SIMULATIONS OF TRANSIENT STORAGE.
Geological Survey, Menlo Park, CA.
K. E. Bencala, D. M. McKnight, and G. W. Zellweger.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 989-1000, May 1990. 14 fig, 2tab, 33 ref.

Descriptors: *Acid mine drainage, *Acid rain, *Acid streams, *Path of pollutants, *Solute transport, *Tracers, Colorado, Lithium, Mathematical studies, Metals, Model studies, Mountain streams, Snake River, Streams.

Physical parameters characterizing solute transport in the Snake River (an acidic and metal-rich mountain stream near Montezuma, Colorado) were variable along a 5.2-km study reach. Stream cross-sectional area and volumetric inflow each varied by a factor of 3. Because of transient storage, the residence time of injected tracers in the Snake River was longer than would be calculated by consideration of convective travel time alone. Distributed inflows along the stream were a significant source of in-stream chemical variations. These transport characteristics of the Snake River were established on the basis of the assumption of lithium as an ideally conservative tracer and use of simulations of advection, dispersion, and transient storage. (Author's abstract)
W90-09171

NATURE OF THE DISPERSIVE FLUX IN SATURATED HETEROGENEOUS POROUS MEDIA.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 2G.
W90-09173

DIFFUSION COEFFICIENTS IN GRAVEL UNDER UNSATURATED CONDITIONS.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5G.
W90-09176

INFLUENCE OF COMPOSTING AND MATURATION PROCESSES ON THE HEAVY-METAL EXTRACTABILITY FROM SOME ORGANIC WASTES.
Centro de Edafologia y Biologia Aplicada del Segura, Murica (Spain). Dept. of Organic Resources.
For primary bibliographic entry see Field 5E.
W90-09184

CADMIUM BIOACCUMULATION IN ORGANS OF THE SCALLOP MIZUHOPECTEN YESSOENSIS.
Akademiya Nauk SSSR, Vladivostok. Inst. Biologii Morya.
Z. S. Evtushenko, O. N. Lukyanova, and N. N. Belcheva.
Marine Biology MBIOAJ, Vol. 104, No. 2, p 247-250, February 1990. 4 fig, 1 tab, 17 ref.

Descriptors: *Bioaccumulation, *Bivalves, *Cadmium, *Heavy metals, *Path of pollutants, *Shellfish, *Zinc, Accumulation, Metals, Scallop, Sea of Japan.

Cadmium and zinc were determined in organs of the Japanese scallop Mizuhopecten yessoensis, collected in 1984 from the Sea of Japan. Cd concentration increased linearly with age (1 to 8 yr) from 39 to 400 microgram/g dry weight in hepatopancreas and from 100 to 640 microgram/g dry weight in kidney. The background level of Cd in the water was 0.1 microgram/liter. Zn concentrations changed only slightly with age. However, Zn levels increased twofold with increased shell size (from 8.5 to 17.0 cm). Cd concentration in muscle, mantle and gill did not exceed 6 microgram/g dry weight in the oldest scallops. In subcellular fractions of the hepatopancreas, cytosolic Cd accounted for 71.7% in 1-year-old scallops and 98.8% in 8-yr-olds. A similar ratio was established for gills, although gill Cd content was an order of magnitude lower. Cd distribution in cytoplasmic proteins in the hepatopancreas showed that the amount of Cd bound to metallothionein-like proteins increased with scallop growth. A considerable amount of Cd also was detected in high molecular weight proteins. (Cassar-PTT)
W90-09196

COPPER UPTAKE BY THE SEA ANEMONE ANEMONIA VIRIDIS AND THE ROLE OF ZOOXANTHELLAE IN METAL REGULATION.
Newcastle upon Tyne Univ. (England). Dept. of Biology.
A. D. Harland, and N. R. Nganro.
Marine Biology MBIOAJ, Vol. 104, No. 2, p 297-301, February 1990. 3 fig, 1 tab, 32 ref.

Descriptors: *Algae, *Anemones, *Bioaccumulation, *Heavy metals, *Path of pollutants, Accumulation, Bioindicators, Coelenterates, Copper, Metals, Zooxanthellae.

Anemonia viridis (Forskal) collected from southwest Scotland and southwest England in October 1988 were exposed to 0.05 and 0.2 mg/L copper in sea water for up to 5 days. At the end of the exposure period Cu levels were about 45 microgram/g dry weight for the 0.05 mg/L exposure and about 60 microgram/g dry weight for the 0.2 mg/liter exposure. Metal uptake by symbiotic anemones (maximum about 7 microgram/g dry weight) was in proportion to external concentrations, suggesting that the anemones regulated copper by expelling symbiotic algae (zooxanthellae) shown to accumulate copper. In contrast, the aposymbiotic anemones accumulated a maximum of about 17 microgram/g dry weight. Mucus produced during the copper exposure was believed to be involved in the metal regulation. (Cassar-PTT)
W90-09197

ENVIRONMENTAL IMPACT OF YARD WASTE COMPOSTING.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
T. Richard, and M. Chadsey.
Biocycle BCYCDK, Vol. 31, No. 4, p 42-46, April 1990. 1 ref, 3 tab, 4 ref.

Descriptors: *Composting, *Groundwater pollution, *Heavy metals, *Soil analysis, *Soil contamination, *Waste disposal, *Water pollution sources, Biological oxygen demand, New York, Phenols.

To evaluate the impact of municipal leaf composting on soil, water, and compost quality itself, an environmental monitoring program examined soil samples for changes in heavy metal content, sampled water infiltrating beneath the site for common water pollution indicators, and tested the finished compost product for nutrients, heavy metals, and pesticide residues. Leaves were collected in Croton-on-Hudson, N.Y. at the curb with vacuum collector trucks, with each truckload weighed as it was brought to the site. A municipal leaf composting can be practiced in an environmentally benign

manner. However, there are a few aspects of this process that can potentially create problems. For leaf composting, the primary concerns are BOD and phenol concentrations found in water runoff and percolation. Biochemical Oxygen Demand and phenols are both natural products of decomposition, but the concentrated levels generated by large scale composting should not be discharged into surface water supplies. Alternatives to surface discharge include such simple technologies as soil treatment, filter strips, or recirculation, so that sophisticated collection and treatment systems should not be needed. Leaf composting, in which decomposition rates are nitrogen limited, does not generate high levels of nitrates or other nitrogen compounds. However, compost facilities that manage high nitrogen materials such as grass clippings, or that use supplemental nitrogen to accelerate leaf decomposition, need to insure that excess nitrogen is not escaping in runoff. The heavy metal content of the leaves was quite low, far below the levels permitted by the New York State Department of Environmental Conservation, and thus did not affect the water, soil, or compost quality. Only few pesticides were detected in the finished compost, and these were all at the low end of the range for background values in suburban soils. The fertilizer content of the compost was typical of compost products currently on the market. The only constraint that should be noted in the use of this compost is the plants. In general the compost should prove an excellent soil amendment for most landscape and gardening uses. (Chonka-PTT)
W90-09204

10,000-YR HISTORY OF NATURAL ECOSYSTEM ACIDIFICATION.
Minnesota Univ., Minneapolis. Dept. of Ecology and Behavioral Biology.
For primary bibliographic entry see Field 2H.
W90-09207

ECOTOXICOLOGY AND ECOSYSTEM INTEGRITY: THE GREAT LAKES EXAMINED.
Wisconsin Univ.-Green Bay.
For primary bibliographic entry see Field 2H.
W90-09213

EFFECT OF SOIL MOISTURE ON THE SORPTION OF TRICHLOROETHENE VAPOR TO VADOSE-ZONE SOIL AT PICATINNY ARSENAL, NEW JERSEY.
Geological Survey, West Trenton, NJ.
J. A. Smith, C. T. Chiou, J. A. Kammer, and D. E. Kile.
Environmental Science and Technology ESTHAG, Vol. 24, No. 5, p 676-683, May 1990. 7 fig, 31 ref.

Descriptors: *Groundwater pollution, *Path of pollutants, *Soil contamination, *Soil water, *Sorption, *Trichloroethene, *Vadose zone, New Jersey, Soil analysis, Soil saturation, Unconfined aquifers.

The impact of moisture on the sorption of tricholorethene (TCE) vapor to vadose-zone soil above a contaminated water-table aquifer at Picatinny Arsenal in Morris County, NJ was assessed. To accomplish this, batch experiments on the sorption of TCE vapor by field soil were carried out as a function of relative humidity. The TCE sorption decreases as soil moisture content increases from zero to saturation soil moisture content, the soil moisture content in equilibrium with 100% relative humidity. The moisture content of soil samples collected from the vadose zone was found to be greater than the saturation soil-moisture content, suggesting that adsorption of TCE by the mineral fraction of the vadose zone soil should be minimal relative to the partition uptake by soil organic matter. Analyses of soil and soil-gas samples collected from the field indicate that the ratio of the concentration in the soil gas is 1 to 3 orders of magnitude greater than the ratio predicted by using an assumption of equilibrium conditions. This apparent disequilibrium presumably results from the slow desorption of TCE from the organic matter of the vadose-zone soil relative to the dissipation of TCE vapor from the soil gas. (Author's abstract)

W90-09217

STUDY OF COPPER(II) ASSOCIATION WITH DISSOLVED ORGANIC MATTER IN SURFACE WATERS OF THREE MEXICAN COASTAL LAGOONS.
Stanford Univ., CA. Dept. of Civil Engineering.
A. M. Hansen, J. O. Leckie, E. F. Mandelli, and R. S. Altmann.
Environmental Science and Technology ESTHAG, Vol. 24, No. 5, p 683-688, May 1990. 3 fig, 3 tab, 36 ref.

Descriptors: *Coastal waters, *Copper, *Heavy metals, *Lagoons, *Mexico, *Model studies, *Path of pollutants, *Speciation, *Water chemistry, Analytical techniques, Chelating agents, Chemical analysis, Surface water, Water sampling.

Copper binding by dissolved organic matter was evaluated by potentiometric titrations on surface waters from three Mexican coastal lagoons. A copper selective electrode technique was utilized to measure cupric ion activity. A model that accounts for the variation in binding intensity as a function of the degree of surface loading was employed to calculate the binding constants of the complex formation between cupric ion and the organic ligands in solution. Small amounts of strongly complexing ligands were present in the dissolved organic fractions. The calculated complex-formation constants show that organic chelates play a significant role in the speciation of Cu(II) in the studied aquatic systems. These organic compounds exhibit polyfunctional character and heterogeneous acidic functional group chemistry and therefore present a broad spectrum of reactivity toward the cupric ion. Metal complexation in such complex ligand systems is often assumed to have a single type of bonding dominate. However, natural polyligands like humics, hydrous oxides, clays, and bacterial surfaces have no constant reaction stoichiometry nor constant reaction energetics. These naturally occurring ligands may be responsible for the availability of some micronutrients and for the inactivation of toxic heavy metals in the studied lagoons. Metal binding intensity is a function of the system composition, so the sites being occupied at high adsorption densities are different from those being occupied at low adsorption density, forming intrinsically weaker adsorption bonds. The modeling approach used takes into account the variation in metal-ligand binding intensity as a function of system composition. This method to evaluate Cu(II)-organic matter interactions is the most appropriate as long as the chemical nature of the dissolved organic substances is not perfectly well-known. (Chonka-PTT)
W90-09218

COLLOIDAL BEHAVIOR OF ACTINIDES IN AN OLIGOTROPHIC LAKE.
Argonne National Lab., IL. Environmental Research Div.
K. A. Orlandini, W. R. Penrose, B. R. Harvey, M. B. Lovett, and M. W. Findlay.
Environmental Science and Technology ESTHAG, Vol. 24, No. 5, p 706-712, May 1990. 8 fig, 7 tab, 17 ref. U.S. Government Contract W-31-109-ENG-38.

Descriptors: *Actinide elements, *Chemical analysis, *Environmental tracers, *Lakes, *Oligotrophic lakes, *Path of pollutants, *Tracers, *Water analysis, *Water chemistry, Colloids, Data acquisition, Wales.

Understanding the speciation of low levels of actinides from fallout and from local sources in freshwater systems is important in order to predict their distributions in the environments. Since these materials make excellent tracers for determining sedimentation rates and other environmental parameters, it is important to determine their physical and chemical properties in relatively pristine systems. Actinide analyses were carried out in an artificial, oligotrophic lake in northwest Wales, United Kingdom, which is used as a source of cooling water for a nuclear power plant. The concentrations of the actinide elements plutonium,

americium, thorium, and curium, and their distributions among different colloidal sizes were determined. Actinide concentrations in the dissolved fraction (less than 0.45 micrometers) were as follows: Pu239,240, 6.4-12.5 fCi/L; Am241, 2.5-18.2 fCi/L; Th232, 0.11-1.09 fCi/L; and Cm244, 0.3-1.4 fCi/L. The majority of the actinides in the lake were retained by hollow-fiber ultrafilters of 5-nm (nominal 100,000 MW) or 100-nm pore sizes; the actinides appeared to be bound reversibly to colloidal material of unknown composition. The two environmentally stable oxidation states of plutonium, IV and V, could be separated by ultrafiltration. These results indicate that submicron colloidal material can dominate the aqueous properties of actinides. (Author's abstract)
W90-09219

MODEL OF THE EXCHANGE OF INORGANIC CHEMICALS BETWEEN WATER AND SEDIMENTS.
Toronto Univ. (Ontario). Inst. for Environmental Studies.
M. L. Diamond, D. Mackay, R. J. Cornett, and L. A. Chant.
Environmental Science and Technology ESTHAG, Vol. 24, No. 5, p 713-722, May 1990. 6 fig, 3 tab, 34 ref.

Descriptors: *Isotopic tracers, *Lake sediments, *Model studies, *Path of pollutants, *Radioisotopes, *Sediment-water interfaces, *Water chemistry, Data interpretation, Mathematical models, Sensitivity analysis, Simulation analysis.

A simple mathematical model was developed to describe the movement of radioisotopes added to lake enclosures, first during initial loss from water to sediments, and second during release from sediments into isotope free water. The model was based on the concept of 'aquivalent' concentration, an equilibrium criterion analogous to fugacity, but suitable for involatile chemicals. It treated two homogeneous compartments, water and an active layer of sediments, and exchange by bidirectional diffusion, sediment deposition, and resuspension. Model simulations of isotope loss agreed well with experimental results obtained for seven isotopes added to two lake enclosures. Simulations of isotope release from sediments were satisfactory but less accurate. The results illustrated that the behavior of isotopes can be estimated from their differing particle-sorption characteristics, as quantified by the isotope-specific Kp and by enclosure specific suspended particle concentrations and sediment deposition/resuspension rates. The model facilitated interpretation of the observations and, in particular, elucidated the roles of transport processes and particle sorption in controlling chemical exchange rates. (Author's abstract)
W90-09220

CONVERSION AND PARTITIONING OF RADIO-LABELLED MERCURY CHLORIDE IN AQUATIC MODEL SYSTEMS.
Lund Univ. (Sweden). Dept. of Ecology.
O. Regnell.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 3, p 548-553, 1990. 6 fig, 4 tab, 29 ref.

Descriptors: *Mercury, *Path of pollutants, *Radioactive tracers, *Water pollution, Methylmercury, Model studies, Sediment analysis, Sediment contamination, Volatility, Water analysis.

Conversion and partitioning of radio-labelled inorganic mercury (203HgCl2) was studied in freshwater model systems composed of sediment and water, or water alone, incubated for up to 10 days. The mercury fractions studied were total 203Hg in water and methyl 203Hg in sediment, and volatilized 203Hg in the gas phase. Water samples were filtered to obtain values for dissolved total 203Hg and methyl 203Hg. Methylated 203Hg was detected in all systems. Most of the methyl 203Hg was bound to the sediments. Net methyl 203Hg production in a system with reduced sediment was an order of magnitude greater than in the other systems. Volatilization of 203Hg was most rapid in

the systems without sediment, while no volatilization took place in sterilized systems. This model system allows for the study of chemical speciation and distribution of mercury in freshwater environments under realistic conditions. By changing physical, chemical, and biological parameters in the system it is possible to study how different conditions influence the fate of mercury. An added advantage of the model system is that methylation and volatilization of mercury can be studied simultaneously. (Author's abstract)
W90-09236

TRANSPORT AND STORAGE OF 137CS AND 210PB IN SEDIMENTS OF LAKE ST. CLAIR.
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
J. A. Robbins, A. Mudrock, and B. G. Oliver.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 3, p 572-587, 1990. 15 fig, 6 tab, 41 ref.

Descriptors: *Cesium radioisotopes, *Lake St Clair, *Lake sediments, *Lead radioisotopes, *Path of pollutants, *Radioisotopes, *Sediment contamination, *Water pollution sources, DDT, Mercury, Polyvinyl chloride, Seasonal variation, Vertical distribution, Water pollution.

In 1985, cores were collected by diver from areas with fine-grained sediments in Lake St. Clair (situated between Lake Huron and Lake Erie). Although the lake is shallow, rapidly flushed, and possesses only a thin layer of postglacial sediment (about 30 cm maximum), 8% of the estimated 137Cs loading from atmospheric nuclear testing in the mid-1960s and 13% of the potential standing crop of excess 210Pb were retained. A sediment column transport model including eddy diffusive mixing, advection, and resuspension, acceptably described the vertical distribution of these radionuclides, as well as stable lead, and implied that such efficient retention may be of recent origin, occurring with the onset of net sedimentation about 100 years ago. The model showed that, at selected sites, the history of lake loading by particle-associated contaminants can be reconstructed from sediment profiles. Horizontally averaged characteristics of the deposit indicate a surface mixed layer mass of 5 g/square cm and tracer residence time of 3 years in accord with residence time of surficial Hg, PCBs (polychlorobiphenyls) and DDT. Trap-collected materials from two sites show markedly contrasting seasonal variations in 137Cs activity reflecting differing proportions of particles derived from inflow (about 300 mBq/gram) and resuspension (< 30 mBq/gram). (Author's abstract)
W90-09237

NITRATE CONTAMINATION OF GROUNDWATER IN NORTH AMERICA.
Agricultural Research Service, Lincoln, NE.
J. F. Power, and J. S. Schepers.
Agriculture, Ecosystems and Environment AEENDO, Vol. 26, No. 3/4, p 165-187, October 1989. 2 fig, 5 tab, 30 ref.

Descriptors: *Fertilization, *Groundwater pollution, *Irrigation practices, *Leaching, *Nitrates, *Nonpoint pollution sources, *North America, *Path of pollutants, *Water pollution sources, Geologic formations, Groundwater quality, Literature review, Manure, Septic tanks, Water management, Well water.

Groundwater serves as the primary domestic water supply for over 90% of the rural population and 50% of the total population of North America. Consequently, protection of groundwater from contamination is of major concern. This paper reviews the problem of controlling nitrate pollution of groundwater in North America. Nitrates in groundwater originate from a number of non-point sources, including geological origins, septic tanks, improper use of animal manures, cultivation (especially fallowing), precipitation, and fertilizers. Accumulation of nitrate N in groundwater is probably attributed to different sources for different regions. Major areas of nitrate pollution often occur under irrigation because leaching is required to control

salt accumulation in the root zone. In the last few decades, areas under irrigation and the use of N fertilizers have increased greatly, and both of these have probably contributed to groundwater nitrate problems. Use of known best management practices (irrigation scheduling, fertilization based on calibrated soil tests, conservation tillage, acceptable cropping practices, recommended manuring rates) has been demonstrated to be highly effective in controlling leaching of nitrates. Government policies are needed that will encourage and reward the use of the best management practices that help control nitrate accumulations in groundwater. (Author's abstract)
W90-09256

NITRATE POLLUTION OF GROUNDWATER IN WESTERN EUROPE.
Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.).
O. Strebel, W. H. M. Duynisveld, and J. Bottcher.
Agriculture, Ecosystems and Environment AEENDO, Vol. 26, No. 3/4, p 189-214, October 1989. 15 fig, 3 tab, 97 ref.

Descriptors: *Europe, *Fertilization, *Groundwater pollution, *Land use, *Leaching, *Nitrates, *Nonpoint pollution sources, *Path of pollutants, *Water pollution sources, Agricultural runoff, Denitrification, Groundwater management, Groundwater quality, Literature review, Well water.

In groundwater recharge areas with large portions of agricultural land, the nitrate concentration of well water has shown rising trends in many countries within the last 2 to 3 decades. Nitrate pollution in groundwater in Western Europe is reviewed. Nitrate leaching from agricultural land must be considered as an important non-point source for nitrate contamination of the groundwater. In the humid regions of Europe, nitrate leaching takes place mainly during autumn, winter, and early spring. Site-specific and land-use-specific data for the mean nitrate N concentration of the annual groundwater recharge show rather high concentrations for sandy soils with arable crops, intensively managed grazed grassland, and field cropping of vegetables. These concentrations can exceed the European drinking water limit of 11.3 mg/L of nitrate N (50 mg/L nitrate) by a factor of between 2 and more than 4. Moreover, conversion of permanent grassland to arable land causes strongly enhanced nitrate leaching for a limited time period. To reduce the nitrate load of groundwater it is very important to minimize the residual nitrate content in the root zone at harvest time, to preserve the nitrate during the main leaching period in the form of biologically fixed plant N within the N cycle, and to minimize the nitrate input of total recharge area of a groundwater well (by enlarging areas with low nitrate inputs at the expense of areas with high nitrate inputs). Results of a closer coordination of fertilizing with the N supply of the soil (nitrate in the root zone in spring, N mineralization) and of cropping of winter catch crops are shown. The site-specific and time-specific nitrate leaching risk during the leaching period is quantified. Nitrate losses by microbial denitrification in the groundwater can play an important role. Quantitative understanding of the complex processes determining the final nitrate concentration of a groundwater well is crucial. All agricultural and groundwater management measures should be applied to secure a sufficient water quality. (Author's abstract)
W90-09257

IMPACT OF AGRICULTURAL PRACTICES ON GROUNDWATER SALINITY.
Agricultural Research Service, Riverside, CA. Salinity Lab.
For primary bibliographic entry see Field 4C.
W90-09258

GROUNDWATER CONTAMINATION BY TRACE ELEMENTS.
California Univ., Davis. Dept. of Land, Air and Water Resources.
K. Tanji, and L. Valoppi.

Agriculture, Ecosystems and Environment AEENDO, Vol. 26, No. 3/4, p 229-274, October 1989. 27 fig, 9 tab, 57 ref.

Descriptors: *Agricultural runoff, *Agriculture, *Groundwater pollution, *Heavy metals, *Nonpoint pollution sources, *Path of pollutants, *Selenium, *Trace elements, *Trace metals, *Water pollution sources, California, Groundwater management, Groundwater quality, Literature review, San Joaquin Valley, Sludge utilization.

Trace element contamination of groundwater by agricultural activities is reviewed. An analysis of reactivity and mobility of trace elements indicated that cationic trace elements (mainly heavy metals) tended to be strongly retained by earth materials due to ion exchange, sorption, and mineral solubility, and do not typically accumulate in groundwater to very high concentrations, the exception being shallow soil profiles with coarse textured soils and large water fluxes. In contrast, anionic trace elements (mainly oxyanions), although retained by earth materials (clays and sesquiozides) to some extent, are subject to greater mobility and may accumulate to high concentrations in groundwater. A case study on application of sewage sludges to cropped soils indicated that heavy metals (Cd, Cr, Cu, Ni, Pb, Zr) accumulated almost entirely on the surface 15 cm soil depth owing to sorption by clays and hydrous oxides of Fe and Mn, complexion by soil organic matter, and precipitation as inorganic minerals. A second case study was presented on trace element accumulation in shallow groundwaters under irrigated lands in the San Joaquin Valley, California, where Se toxicosis to fish and waterfowl was recently discovered resulting from the disposal of saline agricultural drainage waters containing naturally occurring toxic elements. The shallow groundwater problem was described, with extensive data on trace element contamination but with a principal focus on Se, As, Mo, and B. A study of the processes affecting the distribution and mobility of Se indicated that it is highly correlated to salinity levels in the groundwater, and its accumulation of up to 4200 microg/L is the result of leaching of soil Se derived from the Coast Range mountains. These mountains are composed of marine sedimentary rocks and subsequent evaporative salinization of shallow groundwaters, as is documented by delta 018(2) data. The practice of irrigation in this arid climate was shown to have escalated the toxic element problem by mobilizing soil Se, and the particular design of artificial subsurface drainage used in this area appears to collect high concentrations of Se from deeper portions of the shallow groundwater. (Author's abstract)
W90-09259

GENERAL PRINCIPLES OF PESTICIDE MOVEMENT TO GROUNDWATER.
Agricultural Research Organization, Bet-Dagan (Israel). Inst. of Soils and Water.
B. Yaron.
Agriculture, Ecosystems and Environment AEENDO, Vol. 26, No. 3/4, p 275-297, October 1989. 7 fig, 2 tab, 76 ref.

Descriptors: *Fate of pollutants, *Groundwater pollution, *Nonpoint pollution sources, *Path of pollutants, *Pesticides, Adsorption-desorption, Aeration zone, Agricultural runoff, Biodegradation, Chemical degradation, Groundwater quality, Leaching, Mass transport, Mathematical models, Remediation, Research priorities, Soil gases, Soil properties, Solute transport.

Contamination of groundwater through the agricultural use of synthetic organic pesticides potentially involves both point-source and nonpoint-source pollution. During their movement through the unsaturated zone, pesticides interact with the solid and liquid phases of the porous media. The term 'retention' is used to describe the phase distribution (adsorption and desorption) of pesticides in soil. Once a pesticide reaches the soil, it may undergo transformation (biological or chemical degradation), controlled by its chemical properties, the characteristics of the soil medium, the leaching regime, and fluctuations of ambient conditions.

Pesticides may move through the unsaturated zone dissolved in water, as organic vapors, or adsorbed on soil particles. Pesticide movement as a solute in the unsaturated zone may be characterized (1) as liquid diffusion or (2) as mass flow in the water phase. Transport in the gaseous phase is an important movement pathway which affects both the concentration and the distribution of pesticides in the unsaturated zone. Some soils shrink and crack when subjected to wetting and drying cycles; in the wetting cycle, pesticides adsorbed on colloidal material can be transported downward to the groundwater. The need to predict the simultaneous transport of water and pesticides in soil has stimulated the development of a series of mathematical models. A relatively-new approach to evaluating the movement of pesticides uses the model of solute transport on a field scale. But only coordinated research, on a field scale, including physical, physicochemical, and biological aspects will allow us to understand and predict pesticide contamination of groundwater and to suggest ways for unsaturated-zone remediation when pesticide pollution occurs. (MacKeen-PTT)
W90-09260

PESTICIDE POLLUTION OF GROUNDWATER IN THE HUMID UNITED STATES.
Iowa Dept. of Natural Resources, Iowa City.
G. R. Hallberg.
Agriculture, Ecosystems and Environment AEENDO, Vol. 26, No. 3/4, p 299-367, October 1989. 3 fig, 24 tab, 154 ref.

Descriptors: *Groundwater pollution, *Literature review, *Nonpoint pollution sources, *Path of pollutants, *Pesticides, *United States, Agricultural runoff, Agriculture, Corn belt, Fumigants, Groundwater quality, Herbicides, Soil texture, Water pollution sources.

Since 1980, many studies have begun to look at the occurrence of pesticides in groundwater in humid areas; these range from controlled field/plot research studies, to simple monitoring of public water supplies to assess the occurrence of pesticides. Commonly detected pesticides include mobile and/or volatile soil fumigants and nematicides used on vegetable or specialty crops, and herbicides from the humid corn belt regions. A total of 39 pesticides from point and nonpoint sources has been detected in groundwater from 34 states or provinces. Kansas studies suggested that 8 to 10% of private, rural drinking water supply wells and 10% of public water supply wells exhibited pesticide contamination. Surveys in Minnesota and Iowa, states with more intensive pesticide usage, suggested that 30% of the more susceptible public water supply wells and 30 to 60% of private wells were contaminated with pesticide residues. In contrast, Illinois, a very high use state, has detected few pesticides in public water supply wells, except where related to a commercial point source. Controlled plot studies showed the intermittent, often rapid delivery of many pesticides to shallow groundwaters. The preferential flow of water and solutes through soil and rock contributed to the delivery of pesticides to groundwater. Some studies show pesticide leaching more commonly in finer textured soils than coarser, sandy textured soils. Generally, the concentrations of pesticides in groundwater were low, in the 0.1 to 5.0 microg/L range; while pesticide contamination of groundwater merits attention, the concentration of pesticides in drinking water derived from surface waters will typically be greater. (Author's abstract)
W90-09261

PESTICIDE CONTAMINATION OF GROUNDWATER IN WESTERN EUROPE.
Institute for Pesticide Research, Wageningen (Netherlands).
M. Leistra, and J. J. T. I. Boesten.
Agriculture, Ecosystems and Environment AEENDO, Vol. 26, No. 3/4, p 369-389, October 1989. 7 tab, 37 ref.

Descriptors: *Europe, *Fate of pollutants, *Groundwater pollution, *Nonpoint pollution sources, *Path of pollutants, *Pesticides, Agricul-

ture, Aldicarb, Fumigants, Groundwater quality, Herbicides, Literature review, Nematicides, Quantitative analysis, Triazine herbicides, Water pollution sources.

A review of pesticide contamination of shallow and deep groundwater in Western Europe was presented. Certain triazine herbicides and their transformation products have been detected most frequently. The average concentration in measuring series for deep groundwater was usually below 0.1 microg/L, and the highest values were usually below 0.5 microg/L. The concentrations of mecoprop in deep groundwater ranged up to 0.6 microg/L, and those of bentazone to almost 1.0 microg/L. Some other herbicides were found at comparatively high concentrations and the highest values were found for TBA and TCA in tile drain water. The soil fumigant 1,3-dichloropropene was mainly found in shallow groundwater, but its admixture 1,2-dichloropropane was also found in deep groundwater, at concentrations exceeding 10 microg/L. Residues of the nematicides aldicarb and oxamyl have been measured in shallow and intermediate groundwater, but measurements for deep groundwater are still lacking. Some carbamoyl-oximes incubated in subsoil materials exhibited a high rate of transformation in anaerobic subsoils. The maximum admissible concentration of 0.1 microg/L in a Directive of the European Communities of 1980 is the subject of much debate, because a toxicological basis for the directive is lacking. (Author's abstract)
W90-09262

COMPARISON OF NITRIFICATION RATES IN THREE BRANCHES OF THE LOWER RIVER RHINE.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
W. Admiraal, and Y. J. H. Botermans.
Biogeochemistry BIOGEP, Vol. 8, No. 2, p 135-151, September 1989. 8 fig, 2 tab, 24 ref.

Descriptors: *Ammonium, *Fate of pollutants, *Nitrates, *Nitrification, *Nitrites, *Nitrogen cycle, *Path of pollutants, *Rhine River, Comparison studies, Flow rates, Hydrologic systems, Navigation channels, River beds, The Netherlands, Water pollution, West Germany.

The nitrogen cycle in the lower Rhine River was analyzed, using data on concentrations of ammonium, nitrite, and nitrate, measured in the period from 1972 to 1986. The massive discharge of ammonium in densely populated areas of West Germany led to microbial nitrification, detectable as decreases in ammonium and nitrite concentrations in the lower Rhine River over reaches 85-133 km long. The distribution of the nitrogen-rich Rhine waters over three different branches in the Netherlands permits some of the factors governing microbial nitrification in the river bed to be discriminated. In the fast-flowing main channel, intensively used by ships, nitrification is more important than in the smaller branches, despite the short residence time of the water in the main channel. Differences in the flow rate of water, in grain size distribution of sediments, and in intensity of shipping (aeration, turbulence) seemed to be responsible for the different rates of nitrification. (Author's abstract)
W90-09266

UTILISATION OF LIQUID CHROMATOGRAPHY IN AQUATIC PHOTODEGRADATION STUDIES OF PESTICIDES: A COMPARISON BETWEEN DISTILLED WATER AND SEAWATER.
Instituto de Quimica Bio-Organica, Barcelona (Spain). Dept. of Environmental Chemistry.
For primary bibliographic entry see Field 5A.
W90-09269

ORGANOCHLORINE RESIDUES IN WATER FROM THE MAHALA WATER RESERVOIR, JAIPUR, INDIA.
Rajasthan Univ., Jaipur (India). Dept. of Zoology.
P. P. Bakre, V. Misra, and P. Bhatnagar.
Environmental Pollution ENPOEK, Vol. 63, No. 3, p 275-281, 1990. 3 fig, 1 tab, 11 ref. University

Grants Commission Grant No. F. 23-255/84 (SR-II).

Descriptors: *Chlorinated hydrocarbons, *India, *Path of pollutants, *Pesticide residues, *Reservoirs, *Water pollution sources, Aldrin, DDD, DDE, DDT, Groundwater movement, Heptachlor, Jaipur, Mahala Water Reservoir, Pollutant identification, Quantitative analysis, Runoff.

Residues of p,p'-DDE, p,p'DDD, p,p'DDT, the alpha, beta, and gamma isomers of BHC, aldrin, and heptachlor in water from four different sites of the Mahala water reservoir were monitored periodically from September 1985 to October 1987. All the samples contained the above residues in varying concentrations. Isomers of BHC predominated and were followed in relative dominance by aldrin, total DDT and heptachlor residues. p,p'-DDE and p,p'-DDD constituted the major fraction of total p,p'-DDT. Monthly total organochlorine residue levels in water ranged between 1.07 and 81.23 microg/L. The variation is attributed to the run-off or subsoil water movement from the catchment area. (Author's abstract)
W90-09271

INHIBITION OF THE GROWTH OF ENTEROPATHOGENIC BACILLI BY BACTERIOCINS PRODUCED BY MICRO-ORGANISMS FROM THE SEDIMENT OF WELLS.
Talca Univ. (Chile). Dept. of Biological Sciences.
For primary bibliographic entry see Field 5G.
W90-09273

ANTIBIOTIC RESISTANCE OF SALMONELLA STRAINS ISOLATED FROM NATURAL POLLUTED WATERS.
Malaga Univ. (Spain). Dept. of Microbiology.
M. A. Moriñigo, R. Cornax, D. Castro, M. Jimenez-Notaro, and P. Romero.
Journal of Applied Bacteriology JABAA4, Vol. 68, No. 3, p 297-302, March 1990. 1 fig, 2 tab, 26 ref. World Health Organization Grant SPA-06-K.

Descriptors: *Antibiotic resistance, *Biological pollution, *Marine pollution, *Salmonella, *Sewage bacteria, *Stream pollution, Industrial wastewater, Microbiological studies, Spain, Wastewater outfall, Water sampling.

Resistance to 14 antibiotics was tested in 270 Salmonella strains isolated from different aquatic environments. All the strains were sensitive to nalidixic acid (30 microg) and cephalothin (30 microg) but more than 90% were resistant to tetracycline (30 microg). The percentage of strains resistant to other antimicrobial substances depended on the antibiotic and the isolation source. Twenty-four resistance patterns were recorded in strains isolated from three environmental sources (the river water of the Guadalhorce, which receives sewage effluents of a small village; a marine zone at the mouth of the Guadalhorce that receives the industrial wastewaters and sewage of the western part of Malaga; and the marine zone influenced by discharges of a sewage outfall located in Fuengirola, Malaga, Spain), The only multi-resistance detected in the three ecosystems was that of sulfadiazine and tetracycline (about 20%). The serotypes most frequently detected with multi-resistance to different antibiotics were Salmonella typhimurium and Salmonella blockley. (Author's abstract)
W90-09274

OCCURRENCE OF OKADAIC ACID, A MAJOR DIARRHEIC SHELLFISH TOXIN, IN NATURAL POPULATIONS OF DINOPHYSIS SPP. FROM THE EASTERN COAST OF NORTH AMERICA.
Institut Maurice-Lamontagne, Mont-Joli (Quebec). Biological Oceanography Div.
A. D. Cembella.
Journal of Applied Phycology JAPPEL, Vol. 1, No. 4, p 307-310, December 1989. 1 tab, 9 ref.

Descriptors: *Dinoflagellates, *Fish toxins, *Path of pollutants, *Shellfish toxins, *Toxins, Canada, Gulf of St Lawrence, High performance liquid

chromatography, Immunoassay, Okadaic acid, Phytoplankton.

Okadaic acid, one of the principal toxin components implicated in cases of diarrheic shellfish poisoning (DSP), was identified for the first time in natural phytoplankton assemblages from North American waters. During periods in late summer when significant quantities of okadaic acid were detected in net haul samples in the lower estuary and Gulf of St. Lawrence in eastern Canada, the phytoplankton community consistently contained species of the dinoflagellate genus Dinophysis. The presence of okadaic acid was detected by screening dinoflagellate extracts with an enzyme-linked immunological assay; positive results were confirmed by reverse phase high performance liquid chromatography separation, followed by fluorescence detection. Okadaic acid was only found in phytoplankton samples in which the photosynthetic dinophysoid species D. norvegica and D. acuminata were prominent; blooms of the related heterotrophic species D. rotundata exhibited no trace of okadaic acid, nor other suspected DSP components. (Author's abstract)
W90-09277

PESTICIDE CONTAMINATION OF GROUND WATER IN THE UNITED STATES: A REVIEW.
Delaware Univ., Newark. Dept. of Agricultural Engineering.
W. F. Ritter.
Journal of Environmental Science and Health (B) JPFCD2, Vol. 25, No. 1, p 1-29, February 1990. 3 tab, 49 ref.

Descriptors: *Aldicarb, *Atrazine, *Fumigants, *Groundwater pollution, *Nonpoint pollution sources, *Path of pollutants, *Pesticides, *Triazine herbicides, *United States, *Water pollution sources, Agricultural chemicals, Literature review.

A review of pesticides in groundwater in the United States is presented. Over 70 pesticides have been detected in groundwater. Aldicarb and atrazine, along with the soil fumigants 1,2-dibromoethane, 1,2-dichlorophopane, and 1,2-dibromo-3-chlorophopane have been the pesticides most frequently detected in groundwater. Atrazine concentrations have been correlated with high nitrate concentrations. The triazine herbicides simazine and cyanazine have also been detected in groundwater. The annual amount of recharge, soil type, depth of aquifer from the surface, nitrate contamination, and soil pH are important field parameters in determining groundwater contamination potential by pesticides. Pesticide leaching is reduced by proper choice of crop rotation, increasing pesticide application efficiency, and integrated pest management. (Author's abstract)
W90-09278

LYSIMETER STUDIES OF THE EXPERIMENTAL INSECTICIDE BAS 263 I.
Fraunhofer-Inst. fuer Umweltchemie und Oekotoxikologie, Schmallenberg (Germany, F.R.).
M. Herrchen, W. Kordel, W. Klein, and R. T. Hamm.
Journal of Environmental Science and Health (B) JPFCD2, Vol. 25, No. 1, p 31-53, February 1990. 3 fig, 5 tab, 12 ref.

Descriptors: *Field tests, *Groundwater pollution, *Insecticides, *Leachates, *Lysimeters, *Soil contamination, Mathematical models, Metabolites, Path of pollutants, Plant tissues, Radioactive tracers.

The leaching behavior, distribution, and metabolism of the experimental insecticide N-methyl-0-2((2-chloro,1-methoxy)ethoxy)phenylcarbamate (BAS 263 I) were investigated. A lysimeter study of the undisturbed monolith within one year following insecticide application was performed using radioactive tracers. The radiolabelled residues distribution in the leaching water, in 1 m soil, and in plants was analyzed, and the soil monoliths were characterized chemically and microbiologically. Concentrations exceeding 0.1 microg/L of the insecticide or of known metabolites were not found at any time in the leachate. One year after applica-

tion, more than 96% of the persisting radioactive material was detected in the 0-40 cm soil layers as polar non-extractable residues. The insecticide itself was not detected in soil at a limit of 1.8 microg/kg. The total residues in the cultivated crop, especially in the edible parts of the plants, were below 0.13 ng/kg, calculated for the molecular weight of the active ingredient and corresponding to less than 0.14% of the initially applied insecticide. Results on the active ingredient and known metabolites were in agreement with those of a field study. (Author's abstract)
W90-09279

TRACE ELEMENT AND BIOTIC CHANGES FOLLOWING A SIMULATED OIL SPILL ON A MUDFLAT IN PORT VALDEZ, ALASKA.
Alaska Univ., Fairbanks. Inst. of Marine Science.
H. M. Feder, A. S. Naidu, and A. J. Paul.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 3, p 131-137, 1990. 4 fig, 3 tab, 57 ref. EPA grant R800944-02-0.

Descriptors: *Alaska, *Fate of pollutants, *Oil pollution, *Oil spills, *Path of pollutants, *Port Valdez, *Water pollution effects, Clays, Copepods, Mud flats, Sediment contamination, Sediments, Silica, Tidal effects.

A mudflat in Port Valdez, Alaska, was examined to determine effects of experimental additions of Prudhoe Bay crude oil on metal chemistry and harpacticoid copepod abundance. Hydrocarbon concentrations were at background levels 30 days after final addition of oil. The short residence time of oil added to sediments is attributable to physical removal of oil by tides, low sediment permeability, and low affinity of hydrocarbons for periglacial clay surfaces. Elemental concentrations, except Si, were lower in oiled than in unoiled sediments. Elemental depletion in oil-impacted sediments is attributable to mobilization of metals from oxide/hydroxide sediment phases or to desorption from clay due to lowering of oxidation-reduction potential-pH of sediments subsequent to oil addition. In oiled sediments, abundance of the harpacticoid copepods Harpacticus uniremis, Halectinosoma gothiceps, and Heterolaophonte species was similar to or higher than values within unoiled plots. The reasons for lack of deleterious effects of oil on copepods in Port Valdez are not yet understood. (Author's abstract)
W90-09298

MEDITERRANEAN POLLUTION FROM A FERRO-NICKEL SMELTER: DIFFERENTIAL UPTAKE OF METALS BY SOME GASTROPODS.
Athens Univ. (Greece). Zoological Lab. and Museum.
A. Nicolaidou, and J. A. Nott.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 3, p 137-143, 1990. 3 fig, 3 tab, 15 ref. EEC grant STJ-0046-01-UK(TT)/-02-GR(TT).

Descriptors: *Bioaccumulation, *Gastropods, *Greece, *Metals, *Path of pollutants, *Water pollution sources, Cadmium, Chromium, Cobalt, Copper, Environmental effects, Industrial wastes, Iron, Manganese, Nickel, Water pollution effects, Zinc.

At Larymna, in the Northern Evoikos Gulf, Greece, there is a small bay that is dominated by a ferro-nickel smelter which processes locally-mined laterite and imported coal. It produces ferro-nickel granules and ingots together with metalliferous slag. Spillages and dust derived from these materials enter the marine environment. Cadmium, Co, Cr, Cu, Fe, Mn, Ni, and Zn were measured by atomic absorption spectroscopy in the digestive gland of the marine gastropods Cerithium vulgatum, Monodonta species, Murex trunculus, Conus mediterraneus, and Patella coerulea, sampled during different seasons at four sites near the ferronickel smelting plant and two other control sites on the east coast of Greece. Near the smelter there were higher concentrations of all metals (except Cu) in Cerithium and Murex, and of Ni and Co in Monodonta, compared with the control sites, indicating that the plant contaminated the environ-

ment. The animals from the contaminated area showed marked differences in concentrations that were associated both with the genera and the sites, while there were no consistent seasonal variation. (Mertz-PTT)
W90-09299

DISSOLVED AND PARTICULATE MERCURY LEVELS IN THE IONIAN AND AEGEAN SEAS.
Istituto di Biofisica, Pisa (Italy).
R. Ferrara, B. E. Maserti, M. Morelli, and M. A. Panichi.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 3, p 154-155, 1990. 2 fig, 1 tab, 13 ref.

Descriptors: *Aegean Sea, *Greece, *Ionian Sea, *Italy, *Mediterranean, *Mercury, *Water pollution sources, Sampling, Water sampling.

Data for mercury levels in the eastern basin of the Mediterranean are reported. Samples were collected during an oceanographic cruise in March 1989. Samples were collected every 20 miles from the Ionian coast of Calabria, Italy to the Aegean sea, Northern Sporades, Greece. Higher levels of dissolved mercury were found in the Aegean than in the waters of the Ionian Sea. The concentration of mercury that was associated with particulate suspended matter was lower in the Aegean compared with the Ionian Sea. Cinnabar ore deposits present in mineralized areas of the Mediterranean had little or no influence on mercury levels in the water column and in suspended particulate matter. Mercury concentrations were of the same order of magnitude of those measured in the oceans. (Mertz-PTT)
W90-09301

MONITORING WELL INTO ABANDONED DEEP-WELL DISPOSAL FORMATIONS AT SARNIA, ONTARIO.
INTERA Technologies Ltd., Ottawa (Ontario).
For primary bibliographic entry see Field 5E.
W90-09308

DETECTION OF NATURALLY OCCURRING BTX DURING A HYDROGEOLOGIC INVESTIGATION.
Gartner Lee, Inc., Niagara Falls, NY.
D. D. Slaine, and J. F. Barker.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 2, p 89-94, Spring 1990. 1 fig, 2 tab, 17 ref.

Descriptors: *Benzene, *Geochemistry, *Groundwater pollution, *Landfills, *Leaching, *Oil shale, *Path of pollutants, *Toluene, *Water pollution sources, *Xylenes, Baseline studies, Clays, Cores, Flame ionization, Gas chromatography, Glacial till, Limestone, Pollutant identification, Shales, Thermal desorption.

Benzene, toluene and xylenes (BTX) were detected in groundwater during a contaminant hydrogeological investigation of a landfill site. The landfill site was situated on approximately 10m (33 ft) of clay and glacial till overburden soils, which were underlain by a shaly limestone bedrock. The top part of the bedrock was the regional aquifer in the study area. It was initially thought that the landfill was the source of the BTX. However, the BTX was detected in groundwater a considerable distance from the known extent of the leachate plume. Subsequent detailed analysis of rock cores showed the BTX could be leached from bituminous layers of shale that were interbedded in limestone. Rock core testing included gas chromatograph (GC) analysis of organic free reagent water used for leaching tests, flame ionization detection on a solvent used for leaching tests and thermal desorption analysis of the solid rock. The naturally occurring BTX, along with the presence of brackish groundwater in the shaly bedrock, made it difficult to identify groundwater contamination emanating from the landfill. Thus, the presence of BTX should not be considered definitive evidence of groundwater contamination in certain sedimentary rock aquifers. (Author's abstract)

W90-09311

METHOD TO EVALUATE THE VERTICAL DISTRIBUTION OF VOCS IN GROUND WATER IN A SINGLE BOREHOLE.
Lawrence Livermore National Lab., CA. Environmental Restoration Div.
For primary bibliographic entry see Field 5A.
W90-09312

DIFFERENTIATION OF THE ORIGINS OF BTX IN GROUND WATER USING MULTIVARIATE PLOTS.
National Water Research Inst., Burlington (Ontario). Groundwater Contamination Section.
For primary bibliographic entry see Field 5A.
W90-09313

DEVELOPMENT OF A STANDARD, PURE-COMPOUND BASE GASOLINE MIXTURE FOR USE AS A REFERENCE IN FIELD AND LABORATORY EXPERIMENTS.
Arizona State Univ., Tempe. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5A.
W90-09315

INFLUENCE OF CASING MATERIALS ON TRACE-LEVEL CHEMICALS IN WELL WATER.
Cold Regions Research and Engineering Lab., Hanover, NH.
L. V. Parker, A. D. Hewitt, and T. F. Jenkins.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 2, p 146-156, Spring 1990. 10 fig, 4 tab, 26 ref.

Descriptors: *Leaching, *Organic compounds, *Sorption, *Trace metals, *Water pollution sources, *Well casings, *Well water, Alkenes, Aromatic compounds, Arsenic, Cadmium, Chromium, Hydrogen ion concentration, Lead, Monitoring, Organic carbon.

Four well casing materials: polyvinyl chloride (PVC); polytetrafluoroethylene (PTFE); and stainless steel 304 (SS 304) and 316 (SS 316) were examined to determine their suitability for monitoring inorganic and organic constituents in well water. The inorganic study used a factorial design to test the effect of concentration of mixed metals (arsenic, chromium, lead, and cadmium), pH, and organic carbon. Sample times were 0.5, 4, 8, 24, and 72 hours. Except for slow loss of Pb, PTFE well casings had no significant effect on the concentration of metals in solution. For the other casings, changes in analyte concentration often exceeded 10 percent in eight hours or less and, thus, could bias analyses of samples taken from wells constructed with these materials. Specifically, PVC casings sorbed Pb and leached Cd; SS316 casings sorbed As and Pb and leached Cd; and SS 304 casings sorbed As, Cr, and Pb and leached Cd. Both stainless steelcasing materials showed markedly poorer performance than the PVC casings. The well casings were also tested for sorption/desorption of 10 organic substances from the following classes: chlorinated alkenes; chlorinated aromatics; nitroaromatics; and nitramines. Samples times were 0, 1, 8, 24, and 72 hours, seven days and six weeks. There were no detectable losses of analytes in any of the sample solutions containing plastic casings although losses were always more rapid with the PTFE casings than with PVC. Chlorinated organic substances were lost most rapidly. For samples containing PTFE casings, losses of some of these compounds were rapid enough (>10 percent in 8 hours) to be of concern for groundwater monitoring. Losses of hydrophobic organic constituents in samples containing PTFE casings were correlated with the compound's octanol/water partition coefficient. (Author's abstract)
W90-09316

INVESTIGATION OF HAZARDOUS CHARACTERISTICS OF REFINERY WASTEWATER SLUDGES.
Louisiana State Univ., Baton Rouge. Dept. of Civil

Engineering.
W. F. Wimberley, and M. E. Tittlebaum.
Journal of Environmental Science and Health (A) JESEDU, Vol. 24, No. 8, p 863-877, 1989. 5 tab, 10 ref.

Descriptors: *Activated sludge, *Hazardous materials, *Hazardous waste disposal, *Oil refineries, *Regulations, *Sludge treatment, *Wastewater treatment, Chromium, Groundwater pollution, Heavy metals, Resource Conservation and Recovery Act.

An investigation was conducted to determine if sludges deposited in a refinery activated sludge wastewater treatment system exhibited any hazardous characteristics requiring the system to be regulated under the Resource Conservation and Recovery Act (RCRA). One of the major concerns of regulators is that unlined earthen surface impoundments in industrial wastewater treatment trains may be leaking heavy metals such as chromium and other hazardous constituents into the groundwater. The sampling procedures and analytical methods employed for the unlined surface impoundments at the test site were in conformance with EPA document Sw-846--Test Methods for Evaluation of Solid Wastes. The results of sludge testing at the refinery utilized in this study show that none of the sludges exhibit any hazardous characteristics under current testing methodology. Sulfide concentrations ranging from 3.6 to 110 mg/L were liberated in the reactivity tests; however, current EPA internal guidelines do not consider the concentration significant until it exceeds 500 mg/L. Based on the results of wastewater and bottom sludge test results, the wastewater system of the refinery studied is not subject to regulation under current RCRA guidelines. (White-Reimer-PTT)
W90-09319

INFLUENCE OF BEST MANAGEMENT PRACTICES ON WATER QUALITY IN THE APPOQUINIMINK WATERSHED.
Delaware Agriculture Experiment Station, Newark.
For primary bibliographic entry see Field 5G.
W90-09320

VARIATION IN SOME ELEMENT CONTENTS OF WATER HYACINTH DUE TO CADMIUM OR NICKEL TREATMENT WITH OR WITHOUT ANIONIC SURFACE ACTIVE AGENTS.
Okayama Univ. (Japan). Research Inst. for Bioresources.
S. Muramoto, Y. Oki, H. Nishizaki, and I. Aoyama.
Journal of Environmental Science and Health (A) JESEDU, Vol. 24, No. 8, p 925-934, 1989. 2 fig, 6 tab, 11 ref.

Descriptors: *Aquatic plants, *Bioaccumulation, *Cadmium, *Heavy metals, *Nickel, *Path of pollutants, *Surfactants, *Water hyacinth.

The changes in the metal concentrations of water hyacinth (Eichhornia crassipes) due to exposure to cadmium and nickel with and without surface-active agents were determined. The plants were exposed to individual metals in which cadmium and nickel compounds were added at nominal concentrations of 1.0, 4.0, and 8.0 ppm. One series was exposed to sodium dodecyl sulfate (SDS) in addition to the metals. The concentration factors for the roots tended to increase with increasing metal concentration, and were higher than for the plant tops. However, concentration factors were reduced by 18-32% in plant tops and 40-48% in roots when anionic surface-active agents were present in addition to cadmium. In the group containing nickel and surface-active agents concentration factors were reduced by 42-48% in the tops and 55-65% in the roots. The inhibition of metal accumulation in plants due to the addition of 25 ppm surface-active agents was observed for both metals. These changes in plant top and root metal concentrations were observed for cadmium, nickel, aluminum, calcium, silicon, and manganese. (White-Reimer-PTT)
W90-09321

ENHANCED ANAEROBIC BIODEGRADATION OF VINYL CHLORIDE IN GROUND WATER.
Florida International Univ., Miami. Drinking Water Research Center.
For primary bibliographic entry see Field 5G.
W90-09332

IN SITU STUDY ON THE DISTRIBUTION, BIOTRANSFORMATION AND FLUX OF POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) IN AN AQUATIC FOOD CHAIN (SESTON-MYTILUS EDULIS L.-SOMATERIA MOLLISSIMA L.) FROM THE BALTIC: AN ECOTOXICOLOGICAL PERSPECTIVE.
Stockholm Univ. (Sweden). Dept. of Zoology.
D. Broman, C. Naf, I. Lundbergh, and Y. Zebuhr.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 4, p 429-442, April 1990. 4 fig, 3 tab, 73 ref.

Descriptors: *Baltic Sea, *Bioaccumulation, *Biotransformation, *Fate of pollutants, *Food chains, *Path of pollutants, *Polycyclic aromatic hydrocarbons, Carcinogens, Ducks, In situ tests, Mussels, Mutagens, Seston, Tissue analysis.

An in situ study was conducted on the distribution, biotransformation and flux of 19 polycyclic aromatic hydrocarbons (PAH19) in the food chain, seston-blue mussel (Mytilus edulis L.)-common eider duck (Somateria mollissima L.) as well as their distribution in the gallbladder, liver, adipose tissue and egg of the duck. All samples were collected within the open northern Baltic coastal area. Analyses were carried out by gas chromatography/mass spectrometry with electron impact (GC-MSEI) and negative ion chemical ionization (GC-MSNICI). With a multivariate statistical method (SIMCA) a significant change in the PAH composition through the food chain was found. This change probably depends on an increasing metabolic activity with increasing trophic level, due to a selective biotransformation capacity for different PAHs. Decreasing PAH concentrations with increasing trophic level were found. The PAH concentrations in the different eider duck organs were: gallbladder greater than adipose tissue greater than or equal to liver. The theoretical inhalation of air-dispersed PAHs was of no significance compared to the exposure from food. The relatively high theoretical PAH flux through the food chain did not result in increasing concentrations with increasing trophic level, which indicates that PAHs are biotransformed quite fast. However, many intermediate metabolites of PAHs have a mutagenic and carcinogenic potential, which makes it important to observe these compounds when assessing ecotoxicological risks. (Author's abstract)
W90-09334

BACTERIAL MUTAGENICITY OF LEACHATE WATER FROM MUNICIPAL SEWAGE SLUDGE-AMENDED SOILS.
Texas A and M Univ., College Station. Dept. of Soil and Crop Sciences.
For primary bibliographic entry see Field 5C.
W90-09335

MOBILITY AND PERSISTENCE OF ALACHLOR, ATRAZINE AND METOLACHLOR IN PLAINFIELD SAND, AND ATRAZINE AND ISAZOFOS IN HONEYWOOD SILT LOAM, USING FIELD LYSIMETERS.
Agriculture Canada, London (Ontario). Research Station.
B. T. Bowman.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 4, p 453-461, April 1990. 13 fig, 3 tab, 11 ref.

Descriptors: *Fate of pollutants, *Leaching, *Path of pollutants, *Persistence, *Pesticides, *Water pollution sources, Agricultural chemicals, Alachlor, Atrazine, Isazofos, Lysimeters, Metolachlor, Ponding, Soil types, Soil water.

Mobility and persistence of commercial formulations of alachlor, metolachlor and isazofos were studied under two moisture regimes using 75 x 15 cm field lysimeters. Formulated atrazine was also applied to each lysimeter for reference purposes. Alachlor-treated and metolachlor-treated lysimeters were packed with Plainfield sand, while Honeywood silt loam was used to pack isazofos-treated lysimeters. Effluent was monitored for each chemical, and selected cores were sectioned (7 x 10 cm) and analyzed to determine mobility profiles and persistence at weeks 1, 2, 4, 8, 12 and 21. The 50% disappearance times (DT50) for alachlor, atrazine, isazofos and metolachlor were : <1.5, 4, 1.5 and 3 to 4 weeks, respectively. Water application during week 1, following pesticide application, created ponding on Honeywood soil cores, transporting atrazine and isazofos to a maximum 50-cm depth. While isazofos moved no further after week 1, atrazine and desethylatrazine (Des-Atr.) exhibited considerable mobility throughout the study. Ponding on Honeywood silt loam cores produced greater atrazine and Des-Atr. movement than in Plainfield sand cores. Des-Atr. production increased with soil moisture content. Relative mobilities in Plainfield sand were: Des-Atr. greater than or equal to atrazine > metolachlor > alachlor; in Honeywood silt loam: Des-Atr. > atrazine > isazofos. (Author's abstract)
W90-09336

ADSORPTION OF DODECYLTRIMETHYLAMMONIUM CHLORIDE (C12TMAC) TO RIVER SEDIMENT.
Procter and Gamble Co., Cincinnati, OH. Ivorydale Technical Center.
V. C. Hand, R. A. Rapaport, and R. J. Wendt.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 4, p 467-471, April 1990. 2 fig, 2 tab, 15 ref.

Descriptors: *Adsorption, *Fate of pollutants, *Organic compounds, *Path of pollutants, *River sediments, *Sediment contamination, Ion exchange, Sediment-water interfaces.

Adsorption distribution ratios for (14C)-dodecyltrimethylammonium chloride (C12TMAC) to sediment have been measured at realistic environmental concentrations. As observed in previous studies of hydrophobic organic and metal sorption, the distribution ratio was inversely related to the sediment concentration. The value of the distribution ratios varied from 400 L/kg at a sediment concentration of 248,000 mg/L up to 251,000 L/kg at a sediment concentration of 230 mg/L. Data can be fit to Freundlich isotherms with slopes lesser than or equal to 1. Data are consistent with an ion-exchange mechanism. (Author's abstract)
W90-09338

CONDITIONED AVERSION OF ALUMINUM SULFATE IN BLACK DUCKS.
Patuxent Wildlife Research Center, Laurel, MD.
D. W. Sparling.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 4, p 479-483, April 1990. 3 tab, 9 ref.

Descriptors: *Acid rain effects, *Aluminum, *Avoidance, *Ducks, *Foods, *Water pollution effects, Diets, Laboratory methods, Path of pollutants.

A study was conducted on the response of black ducks to diets with a high aluminum concentration because concentrations of Al cations increase in water affect by acid precipitation and foods consumed by waterfowl using such waters may also have higher Al concentrations than neutral waters. Three experiments were conducted to determine if the reduced consumption of foods with elevated Al levels by black ducks (Anas rubripes) in previous studies was due to taste aversion, conditioned taste aversion or malaise. Black ducks preferred a diet with 1,000 ppm Al over a control diet but ate less of a diet with 5,000 ppm Al. Prior experience with the high Al diet enhanced preference for the control diet. Changes in body weight and food consumption through time suggest that aversion to the high Al diet was a conditioned response to mild malaise. (Author's abstract)

W90-09339

RELATIONSHIP BETWEEN AQUATIC TOXICITY AND OXIDATIVE DEGRADATION OF UNSUBSTITUTED PHENYLENEDIAMINES.
Du Pont de Nemours (E.I.) and Co., Newark, DE. Haskell Lab. for Toxicology and Industrial Medicine.
R. G. Stahl, P. H. Lieder, and D. G. Hutton.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 4, p 485-488, April 1990. 3 tab, 12 ref.

Descriptors: *Degradation, *Fate of pollutants, *Hydrocarbons, *Toxicity, Acute toxicity, Chemical wastes, Daphnids, Dyes, Minnow, Oxidation.

The static acute toxicities and degradative rates of the unsubstituted phenylenediamines (pdas) varied significantly among the ortho, para and meta isomers. With fathead minnows, the nominal 96-h LC50s were 0.06, 44 and 1,600 mg/L for p-pda, o-pda and m-pda, respectively. In daphnid tests, the nominal 48-h EC50s were 0.28, 0.87 and 5.9 mg/L for p-pda, o-pda and m-pda, respectively. The nominal 96-h EC50s in algae were 0.28, 0.16 and 2.4 mg/L for p-pda, o-pda and m-pda, respectively. With oxygenation, the times to reach 1/2 initial concentrations were 4 to 9 h for p-pda, 650 to 1,100 h for o-pda and 3,200 to 8,100 h for m-pda. Results suggest acute toxicities of pdas are related to their chemical reactivities (degradative rates) and that pdas may degrade rapidly under environmental conditions. (Author's abstract)
W90-09340

GROUND AND SURFACE WATER QUALITY IMPACTS OF NORTH CAROLINA SANITARY LANDFILLS.
North Carolina State Univ., Raleigh. Dept. of Civil Engineering.
R. C. Borden, and T. M. Yanoschak.
Water Resources Bulletin WARBAQ, Vol. 26, No. 2, p 269-277, April 1990. 5 fig, 4 tab, 19 ref.

Descriptors: *Groundwater pollution, *Hazardous wastes, *Heavy metals, *Landfills, *Leachates, *Metals, *Municipal wastes, *North Carolina, *Organic compounds, *Water pollution sources, Arsenic, Cadmium, Chlorinated hydrocarbons, Chromium, Conductivity, Dissolved solids, Hydrocarbons, Lead, Monitoring wells, Organic carbon, Pesticides, Statistical analysis, Turbidity, Zinc.

Ground and surface water quality monitoring data from 71 municipal sanitary landfills in North Carolina were analyzed to determine the nature and extent of current contamination problems and identify any common characteristics associated with this contamination. A total of 322 surface and 411 groundwater quality records were analyzed using the statistical analysis system (SAS). Landfills are having measurable impacts on ground and surface water quality, but these impacts may not be as severe as is commonly assumed. Statistically significant increases were detected in the average concentrations in groundwater and downstream surface water samples when compared to upstream surface water samples. The largest percentage increases were observed for zinc, turbidity, total organic carbon, conductivity, total dissolved solids, and lead. Violations of groundwater quality standards for heavy metals and hazardous organic compounds were detected at 53% of the landfills where adequate data existed. The most common heavy metal violations were for lead (18%), chromium (18%), zinc (6%), cadmium (6%), and arsenic (6%) (percentage of landfills violating shown in parenthesis). The organic compounds that appear to pose the greatest threat to groundwater are the chlorinated solvents (8%), petroleum derived hydrocarbons (8%), and pesticides (5%). A comparison of monitoring data from sanitary landfills and secondary wastewater treatment plants suggests that the concentrations of heavy metal and organic pollutants discharged to surface waters from these two sources are similar. (Author's abstract)
W90-09351

SOLUTE INPUT INTO GROUNDWATER FROM SANDY SOILS UNDER ARABLE LAND AND CONIFEROUS FOREST: DETERMINATION OF AREA-REPRESENTATIVE MEAN VALUES OF CONCENTRATION.
Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.).
O. Strebel, and J. Bottcher.
Agricultural Water Management AWMADF, Vol. 15, No. 3, p 265-278, May 1989. 7 fig, 1 tab, 22 ref.

Descriptors: *Analytical methods, *Arable soils, *Coniferous forests, *Groundwater pollution, *Path of pollutants, *Solute transport, Groundwater recharge, Land use, Leaching, Sampling, Sand.

With respect to groundwater quality problems, solute concentrations of the top groundwater are frequently used as a measure for the concentrations of the solute input by groundwater recharge. In a recharge area with sandy soils under arable land and coniferous forest, the land-use-specific concentration of nine solutes were measured at 39 points on six different sampling dates. The data, combined in one entire sample for each solute, were found log-normally distributed, except for nitrate concentration and pH for arable land and the concentration of aluminum and sulfate and pH for coniferous forest, which show a normal distribution. The variation coefficient of the mean concentration values is, in many cases, in the range of greater than or equal to 100%. Under arable land we found higher concentrations of NO_3, K, Ca, Mg, and Cl, but under coniferous forest higher concentrations of Al, SO_4, and H. According to the variograms, the measured data are spatially independent at lag distances of h greater than or equal to 100 m. If land-use-specific, area-representative mean values of a given error probability (requiring a given sample size) are intended, information on the leaching behavior of solutes in question is needed. For solutes with a pronounced concentration maximum during the annual course of leaching, like nitrate under arable land conditions, the variability in time must be taken into account when choosing the sampling strategy (repeated sampling at carefully timed sampling dates). For solutes without any pronounced annual course of leaching, like sulfate under coniferous forest, sampling at many points on only one sampling date will be appropriate. (Author's abstract)
W90-09366

ACID RAIN: CAUSE AND CONSEQUENCE.
Imperial Coll. of Science and Technology, London (England). Centre for Environmental Technology.
B. J. Mason.
Weather WTHRAL, Vol. 45, No. 3, p 70-79, March 1990. 3 fig, 1 tab.

Descriptors: *Acid rain, *Acid rain effects, *Path of pollutants, *Research priorities, *Water pollution sources, Atmospheric chemistry, Dry deposition, Research programs, Soil chemistry, Surface water.

Acid rain is commonly used to describe all acid deposition from the atmosphere that may cause ecologic and economic damage. In fact precipitation brings down only about one-third of the total acid in the UK; two-thirds being deposited in the dry state as gases and small particles. It is difficult to define one single cause of acid rain and the damage it causes. It is often the result of a combination of several contributory factors, some acting synergistically, others in opposition. The Royal Society, the Norwegian Academy of Science and Letters, and the Royal Swedish Academy of Science established a five year research program to examine the many aspects of the acidification of surface waters in the three countries. The transport and chemical transformation of emitted pollutants in the atmosphere, the wet and dry deposition of the resulting acids, the acidity and chemical composition of the rain and snow, modification of the chemistry of the rainwater as it percolates through and interacts with the soil and rocks, and the toxic effects of the modified water chemistry on aquatic biota in streams and lakes are among the subject areas being investigated. (Marks-PTT)
W90-09370

COMBINED SEWER OVERFLOW PROBLEM: AN OVERVIEW.
Moffa and Associates, Syracuse, NY.
For primary bibliographic entry see Field 5G.
W90-09376

METALS SPECIATION, SEPARATION, AND RECOVERY. VOLUME II.
Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. 1990. 632p. Edited by James W. Patterson and Roberto Passino.

Descriptors: *Chemical reactions, *Chemical recovery, *Chemical speciation, *Metals, *Path of pollutants, *Symposium, *Urban hydrology, Case studies, Chemical precipitation, Cleanup, Conferences, Decontamination, Soil contamination, Sorption, Waste recovery.

The proceedings contains two keynote addresses and 24 scientific and technical papers presented at the symposium, together with a written discussion of each paper. Section divisions are: (1) Chemistry of Toxic Metals; (2) Precipitation Phenomena; (3) Metal Speciation and Complexation in Natural Systems; (4) Sorption onto Surfaces; (5) Ion Separation; (6) Soils Contamination and Decontamination; and (7) Waste Reduction and Recovery Case Studies. (See W90-099382 thru W90-09407) (Lantz-PTT)
W90-09381

CYCLES, FLUXES AND SPECIATION OF TRACE METALS IN THE ENVIRONMENT.
Essex Univ., Colchester (England). Inst. of Aerosol Science.
R. M. Harrison.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 3-26, 7 fig, 5 tab, 26 ref.

Descriptors: *Path of pollutants, *Research priorities, *Trace metals, *Urban hydrology, Air pollution, Data acquisition, Fluctuations, Heavy metals, North Sea, Plant growth, Rivers, Soil contamination, Water pollution.

For each metal, processes such as atmospheric wet and dry deposition, aquatic speciation, partitioning, precipitation and accumulation in sediments are generally rather well understood in terms of the process efficiency and mechanism, and there is an increasing body of knowledge on chemical speciation. However, to develop a full comprehension of the knowledge necessary for the control of trace metals in the environment, a greatly improved knowledge of metal fluxes through the various environmental pathways is needed. There have been two main approaches to the estimation of atmospheric input fluxes: using deposit gauges to collect total deposition for analysis; and measuring airborne concentrations over the sea, which This may be performed using static platforms, aircraft or ship-borne samplers. For most metals, river inputs represent the major estimated source of input to the North Sea. These fluxes are again very difficult to quantify reliably. Many data sets have been obtained using analytical methods of inadequate sensitivity and include many values below detection limit. A continuous flow-proportional water sampler has been operated in a major U.K. River. The sampler collects up to 2000 5-mL subsamples of water over a one week period at a frequency which is adjusted continuously in response to discharge as measured by an ultrasonic flow gauge. It produces a one week flow-proportional sample, and the weekly load is estimated. Apportionation of the contributions arising from the soil and atmospheric sources is experimentally difficult, but has been achieved by the use of three methods, all of which give results in broad agreement: (1) addition of isotopic tracers to soils; (2) use of a dual plant growth cabinet in which plants are grown in two chambers identical except for the fact that one is ambient air; and (3) plants grown on an identical soil in locations using widely differ-

ent air metal concentrations. Concentration factors vary greatly between elements, with a general order of $Zn > Cd > Ni > Cr > Pb$ irrespective of the plant type, reflecting the relative availability of these metals for uptake. (See also W90-09381) (Lantz-PTT)
W90-09382

EFFECT OF SPECIATION ON THE RATES OF OXIDATION OF METALS.
Rosenstiel School of Marine and Atmospheric Science, Miami, FL.
For primary bibliographic entry see Field 2K.
W90-09387

SPECIATION OF TIN IN SEDIMENTS OF ARCACHON BAY (FRANCE).
Universite de Pau et des Pays de l'Adour (France). Lab. de Chimie Analytique.
M. Astruc, R. Lavigne, R. Pinel, F. Leguille, and V. Desauziers.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 263-274, 5 fig, 1 tab, 9 ref.

Descriptors: *Antifoulants, *Arcachon Bay, *Biodegradation, *Chemical speciation, *Contaminated sediments, *Dibutyltin, *Fate of pollutants, *France, *Path of pollutants, *Tin, *Tributyltin, *Urban hydrology, Monobutyltin, Tin compounds.

Arcachon Bay, close to Bordeaux in the Southwest Atlantic coast of France, is the first place in the world where the impact of tributyltin (TBT) pollution on the marine environment was observed. From circumstantial evidence, French authorities came to the conclusion that TBT-based antifouling paints were the primary cause of this contamination. In January 1982, a ban was imposed on the use of these paints for pleasure crafts of 25 M or less except those with aluminum hulls. Monitoring of total tin and organotin compounds in both sea water and oysters from 1981-1985 showed a steady decrease in sea water and oysters. However, some shell malformations remained. In deeply buried layers of intertidal sediment (10-20 cm), that were polluted 8-15 years ago, the major component of organotin speciation is still tributyltin with minor contributions of expected degradation products, dibutyltin and monobutyltin. In these anoxic conditions the half-life time of TBT must be expressed in years at least or rather in decades. Such a low degradation rate may perhaps be linked to inhibition of microbial activity at the high TBT concentrations found. The mobility of butylated tin species is low, decreasing in the order MBT > DBT > TBT, and seems to be maximal in the top centimeters of sediment. Methylated tin species are not important components in the samples studied, as no and methylbutyltin compounds have been found. Deeply buried sediments in Arcachon Bay may store large amounts of TBT whose release toward overlying waters could have disastrous consequences. However, the mobility of TBT in these conditions seems to be low. Systematic investigations along the French Atlantic coast should be undertaken to validate these findings on a more general basis. Dredging operations with these polluted sediments should be considered only with great care. (See also W90-09381) (Lantz-PTT)
W90-09392

METAL COMPLEXATION BY WATER-SOLUBLE ORGANIC SUBSTANCES IN FOREST SOILS.
Vrije Univ., Amsterdam (Netherlands). Dept. of Ecology and Ecotoxicology.
A. T. Kuiters, and W. Mulder.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 283-297, 3 fig, 3 tab, 18 ref. Program Office for Fundamental Soil Research (the Netherlands) Project 8936.

Descriptors: *Chemical speciation, *Forest soils, *Heavy metals, *Metal complexes, *Organic matter, *Path of pollutants, *Urban hydrology, Aluminum, Bioaccumulation, Copper, Detritus, Fate of pollutants, Iron, Leaching, Lead, Leaves, Manganese, Zinc.

Freshly fallen leaves of oak and poplar trees were subjected to leaching under controlled laboratory conditions and the leachates were analyzed for soluble organic substances with metal-complexing abilities. By using a modified size-exclusion chromatographic technique, the soluble organics in the litter solutions were fractionated into distinct molecular weight groups and the metal-complexing capacity of each group was determined at the same time. Analyses of the leachates revealed the presence of two apparent molecular weight groups, with different leaching rates and metal-binding abilities. Group I compounds, with highest molecular weight and with polysaccharides and polyphenols as the presumably main components, had the ability to form strong metal-complexes. These compounds were only gradually released by leaching of the litter material. Group II, with low-molecular weight organic and phenolic acids presumably as the predominant compounds, had metal-complexing abilities as well, but with low to moderate strength. These compounds were rapidly leached from the leaf litter. In contact with the humus layer of forest soils, these litter leachates promoted the solubilization of metal ions (Al, Fe, Cu, Pb, Zn and Mn). This was revealed by batch equilibrium experiments. For Al and Fe this was effectuated by strong complexants, presumably compounds of relatively high molecular weight (group I). The solubilization of Pb, Cu, Zn and Mn was correlated with the presence of low-molecular weight compounds (group II). The release of soluble organic substances from the top-layer of forest soils and the subsequent mobilization of metal ions by the percolating litter solutions may have serious consequences for the availability of (heavy) metals for uptake by the vegetation and facilitates the vertical transport of the complexed metals through the soil profile. (See also W90-09381) (Author's abstract)
W90-09393

PROTON AND METAL ION BINDING ON HUMIC SUBSTANCES.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Plant Nutrition.
J. C. M. De Wit, W. H. van Riemsdijk, and L. K. Koopal.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 329-353, 7 fig, 25 ref. European Comity Environmental Research Programme on Soil Quality Contract EV4V-011-NL(GDF).

Descriptors: *Chemical reactions, *Fate of pollutants, *Humic substances, *Metal complexes, *Metals, *Path of pollutants, *Urban hydrology, Adsorption, Chemical analysis, Kinetics, Model studies, Molecular structure, Organic matter, Phthalic acid, Salicylic acid.

The interaction of protons and metal ions with humic substances is analyzed. Specific attention is paid to effects of the site density, particle radium and ionic strength on the adsorption behavior. It is suggested to plot the proton adsorption isotherm, theta-sub-H, as a function of pH, the proton activity at the plane of adsorption instead of the pH. Coinciding theta-sub-H(pH) curves at different ionic strength indicate that an appropriate double layer model has been used. Proton adsorption data on several humic acids have been analyzed. For metal ion adsorption multicomponent (M,H) isotherm equations result. Adsorption isotherms for a monodentate positive surface complex are considerably different from those leading to a monodentate uncharged metal-surface complex. The adsorption isotherms for bidentate metal ion complexes formed on phthalic acid or salicylic acid-like surface structures are identical to the isotherms for the monodentate complexes as long as the dissocia-

tion of the second surface groups of the phthalic acid and salicylic acid surface structures is negligible. (See also W90-09381) (Author's abstract)
W90-09395

CHEMICAL SPECIATION OF HEAVY METALS IN SOILS FOLLOWING LAND APPLICATION OF CONDITIONED BIOLOGICAL SLUDGES AND RAW PIG MANURE.
Pavia Univ. (Italy). Dept. of Hydraulic and Environmental Engineering.
For primary bibliographic entry see Field 5E.
W90-09397

PARTITIONING OF HEAVY METALS INTO SELECTIVE CHEMICAL FRACTIONS IN SEDIMENTS FROM RIVERS IN NORTHERN GREECE.
Thessaloniki Univ., Salonika (Greece). Environmental Pollution Control Lab.
V. Samanidou, and K. Fytianos.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 463-472, 1 fig, 4 tab, 21 ref.

Descriptors: *Chemical speciation, *Cleanup, *Greece, *Heavy metals, *Path of pollutants, *River sediments, *Urban hydrology, Aliakmon River, Axios River, Cadmium, Carbonates, Cation exchange, Chromium, Copper, Iron, Lead, Manganese, Sulfides, Zinc.

A fine-step sequential extraction technique was used to determine the chemical association of heavy metals (Pb, Cd, Cu, Fe, Mn, Zn, Cr) with major sedimentary phases (exchangeable cations, easily reducible compounds, organic sulfidic phases, carbonates and residual components) in samples from rivers in northern Greece (Axios and Aliakmon). From the data obtained it can be seen that the surplus of metal contaminants introduced into the aquatic system from anthropogenic sources usually exists in relatively unstable chemical forms. A high proportion of the elements studied remains in the residual fractions for the Axios River and in the organic fraction for the Aliakmon indicating a different origin and transport media of the metals in the two rivers. Concerning total sediment concentration, the Axios River had high concentration of Fe, Mn, Zn, Pb, and Cd, of these, Fe had the highest concentration. Most of the non-residual portion is bound to ferromanganese oxides and to organic matter. (See also W90-09381) (Author's abstract)
W90-09401

ATMOSPHERIC DEPOSITION.
Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. 288p. Edited by Jacques W. Delleur.

Descriptors: *Acid rain, *Acid rain effects, *Air pollution, *Path of pollutants, *Water pollution sources, Ecological effects, Model studies, Nitric acid, Precipitation, Statistical analysis, Sulfates, Sulfuric acid, Symposium, Water pollution effects.

The atmosphere operates as a reservoir in which numerous chemical reactions take place and in which the wind transports these compounds over hundreds of thousands of kilometers. Although oxygen, carbon dioxide, nitrogen and sulfur compounds are released by natural processes, the large scale discharge of sulfur dioxide and nitrogen oxides in the atmosphere come from anthropogenic sources. Sulfuric and nitric acids are formed and very high acidities are found at the base of clouds. Acid rain and dry sulfates and other particles reach the ground and the vegetation. These wet and dry depositions undergo physical and chemical changes as they progress through the terrestrial phase of the hydrological cycle. Research efforts have recently concentrated on regional transport and atmospheric chemistry of pollutants and on the effect of acid deposition on ecosystems. These

proceedings cover many of these research aspects. Global and regional modeling of acid deposition and removal rates are discussed in the first section. Though the problem of control of acid deposition is principally a political one, this is discussed in the second section (i.e. conflict analysis and systems analysis are techniques used in the study of abatement strategies). Sections III and IV concentrate on the measurement and composition of acid deposition. Statistical analysis in Section V is used to understand the variations in precipitation chemistry, or in the determination of the sources of deposition. The next two sections deal with the ecologic impacts of acid deposition; in Section VI the emphasis is on the hydrologic response to acid deposition while Section VII presents research studies on the effect of acid deposition on forest and canopy. (See W90-09409 thru W90-09439) (Lantz-PTT)
W90-09408

SIMULATED GLOBAL DEPOSITION OF REACTIVE NITROGEN EMITTED BY FOSSIL FUEL COMBUSTION.
National Oceanic and Atmospheric Administration, Princeton, NJ. Geophysical Fluid Dynamics Lab.
H. Levy.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 3-9, 1 fig, 3 tab, 15 ref.

Descriptors: *Acid rain, *Air pollution, *Fossil fuels, *Model studies, *Nitrogen, *Path of pollutants, *Simulation analysis, *Water pollution sources, Asia, Canada, Europe, Fuel, United States.

The medium resolution (265 km horizontal grid) Geophysical Fluid Dynamics Laboratory (GFDL) general circulation transport model was used to simulate the global deposition of reactive nitrogen emitted by fossil fuel combustion. The nitrogen species are transported as a single tracer. The global parameter for wet deposition is based on the observed wet deposition of nitrogen over North America, and constant bulk coefficients for dry deposition over land and sea are pre-calculated from measured concentrations and deposition velocities. The simulated yearly wet depositions in Europe, as well as at nearby and distant export sites, are in reasonable agreement with observations. The agreement is generally quite good and almost always within a factor of 2. No more than 1.4 Tg of the 21.3 Tg of nitrogen emitted by fossil fuel combustion are deposited in the Southern Hemisphere, yet this source accounts for < 10% of the apparent background deposition. The 4 Tg of nitrogen exported by the three major source regions (US/Canada, Europe, and Asia) accounts for most of the deposition over the remote Northern Hemisphere. The simulated deposition over the North Pacific, which is in good agreement with estimates based on recent observations, is dominated by emissions from Asia, while US/Canadian emissions dominate deposition over the North Atlantic. (See also W90-09408) (Author's abstract)
W90-09409

COMPARISON OF PARAMETERIZED NITRIC ACID REMOVAL RATES USING A COUPLED STOCHASTIC-PHOTOCHEMICAL TROPOSPHERIC MODEL.
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
R. W. Stewart, A. M. Thompson, and M. A. Owens.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 11-18, 2 fig, 1 tab, 15 ref.

Descriptors: *Acid rain, *Model studies, *Nitric acid, *Path of pollutants, *Stochastic models, Air pollution, Mathematical models, Mathematical studies, Photochemistry, Precipitation.

The major tropospheric loss of soluble species, such as nitric acid, results from scavenging by water droplets. A problem of practical importance associated with such processes is the calculation of the soluble species residence time since this can provide an estimate of the degree to which such species may influence air quality at locations remote from their sources. Since the removal of soluble species is a nonlinear process, a simple average over wet and dry periods can lead to erroneous results. A coupled stochastic-photochemical model has been developed to calculate the concentrations of tropospheric species, some of which are subject to intermittent losses due to randomly generated precipitation events. The numerical results indicate that the HNO3 residence time is sensitive to the assumption of randomly distributed precipitation events. Nonrandom events having the same 24 hour period as randomly distributed rain may result in substantially different residence time. The assumption of randomly distributed precipitation events is not in agreement with observations for various regions, seasons, and precipitation types. The calculation of accurate effective loss rates will require more realistic statistical descriptions of precipitation than those employed thus far in photochemical modeling. (See also W90-09408) (Lantz-PTT)
W90-09410

MODELING THE FORMATION AND DEPOSITION OF ACIDIC POLLUTANTS.
State Univ. of New York at Albany. Atmospheric Sciences Research Center.
C. J. Walcek, and J. S. Chang.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 21-26, 5 fig, 4 ref.

Descriptors: *Acid rain, *Air pollution, *Mathematical models, *Model studies, *Path of pollutants, *Water pollution sources, Ammonia, Carbon monoxide, Cloud chemistry, Indiana, Nitrogen compounds, Organic compounds, Precipitation, Regional Acid Deposition Model, Sulfur dioxide.

A sophisticated mathematical model of the chemistry, transport, and deposition of tropospheric trace gases provides a useful tool for assessing the relationship between emission and deposition of atmospheric pollutants. The three-dimensional Regional Acid Deposition Modeling system (RADM) calculates short-term concentrations and wet and dry deposition of trace species over the northeastern U.S. and Canada. Emissions of SO2, nitrogen oxides, organic compounds, ammonia, and carbon monoxide are specified using a comprehensive pollutant emission inventory. The model calculates the transport and chemical transformation rate of these compounds and other secondary pollutants (e.g. ozone, sulfuric acid, nitric acid) using meteorology data and a detailed gas-phase chemical reaction mechanism. A cloud chemistry and scavenging model computes trace species aqueous chemistry and wet deposition rates during cloudy period, and dry deposition rates to underlying surfaces are calculated for many chemical species. The Oxidation and Scavenging Characteristics of April Rains (OSCAR) field study was used for model evaluation. During this study, a network of about 36 aqueous chemistry samplers collected precipitation over the northeast U.S. and Canada during four storm events in April 1981. A frequency distribution of the sulfate, nitrate and water deposition for the fine-resolution network of precipitation samplers in northern Indiana showed that in all cases, the median deposition is 10-20% below the 'average' deposition to the sampling area. This implies that for storm events in this sampling area, a randomly selected site would be more likely to receive less deposition than the average deposition to the area. These data further suggest that the model is capable of calculating deposition of acidity to within the observed variability of trace species deposition during individual precipitation events. (See also W90-09408) (Lantz-PTT)
W90-09411

PRECIPITATION DATA COMPATIBILITY IN NORTH AMERICA AND THE IMPACT ON STUDIES OF ACID DEPOSITION.

Canadian Climate Centre, Downsview (Ontario).
For primary bibliographic entry see Field 7B.
W90-09414

CHEMICAL COMPOSITION OF PRECIPITATION, DEW AND FROST, AND FOG IN DENVER, COLORADO.

Geological Survey, Lakewood, CO. Water Resources Div.
L. J. Schroder, T. C. Willoughby, R. B. See, and B. A. Malo.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 83-90, 3 tab, 16 ref.

Descriptors: *Acid rain, *Air pollution sources, *Denver, *Path of pollutants, *Precipitation, *Water pollution sources, Calcium, Chemical analysis, Chlorides, Colorado, Dew, Fluorides, Fog, Frost, Hydrogen ion concentration, Lead, Magnesium, Pollutant identification, Sodium, Zinc.

Samples of precipitation, dew and frost, and fog were collected at a site in the northwestern part of the Denver, Co., metropolitan area. Cluster analysis of the chemical composition of urban precipitation indicates that there is a relation among calcium, magnesium, sodium, chloride, and fluoride. The relation probably is related to the scavenging of soil-derived particulate matter by precipitation. Dew and frost samples indicate that the chemical composition is affected substantially by the dissolution of particulates on the collection surface. The pH of dew and frost had a median value of 6.4, which was greater than the median values of either precipitation or fog. The zinc concentration in dew and frost samples indicates that anthropogenic particulates are being dissolved by the dew and melting frost. The maximum pH was 4.4 in three fog samples collected, which indicates that urban fog samples are more acidic than either precipitation or dew and frost. Lead concentrations in the fog samples indicate that fog is scavenging aerosols produced by the combustion of leaded gasoline. (See also W90-09408) (Author's abstract)
W90-09418

DISTRIBUTION, CHEMICAL AND ISOTOPIC CHARACTERISTICS OF PRECIPITATION EVENTS IN AN ARID ENVIRONMENT - MAKHTESH RAMON BASIN, ISRAEL.

Hebrew Univ. of Jerusalem (Israel). Seagram Centre for Soil and Water Sciences.
R. Nativ.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 91-99, 5 fig, 16 ref.

Descriptors: *Acid rain, *Israel, *Makhtesh Ramon Basin, *Path of pollutants, *Water pollution sources, Bicarbonates, Calcium, Calcium chloride, Chemical analysis, Chlorides, Magnesium, Pollutant identification, Potassium, Precipitation, Rain gages, Sodium, Sulfates.

Forty-six individual rain events and successive fractions of these events were studied in the arid Makhtesh Ramon Basin, southern Israel, during 1981-1983. Large variations were observed in annual rainfall (47-107 mm), number of rain events per year (8-20), start of the rainy season (September to January), its termination (March to May) and length (4-9 months). About 85% of the rain events were recorded at more than one station, indicating an aerial distribution exceeding 20 km. Dust samples revealed the following soluble ions: Ca >> Mg > Na > K and HCO3 > Cl > SO4. Rain composition of 61 analyzed samples revealed: Ca > Na > Mg > K and HCO3 > Cl > SO4 and neutral pH of 7.1-7.6. Both dust and rainwater contained CaCl2. Two distinct sources of dissolved ions were inferred: dust, providing mainly

Ca(HCO3)2, and cloud-borne sea spray, providing mainly Na, Mg, Cl and SO4. A chemical and isotopic amount effect was observed--the rain of the rainier year contained 34% less dissolved ions and was isotopically lighter in gamma-18-O by 54% than the rain of the less rainy year. A chemical and isotopic front effect was observed--the first fraction of the individual rain events contained more dissolved ions (32-69%) and was enriched by more gamma-18-O (31%) than the subsequent rain fractions. (See also W90-09408) (Author's abstract)
W90-09419

COMPARISON OF IONIC COMPOSITION OF CLOUDWATER WITHIN AND ABOVE THE CANOPY OF AN ABOVE CLOUDBASE FOREST.

North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.
T. P. DeFelice.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 101-107, 2 fig, 2 tab, 15 ref. EPA Contracts 813934-01-2, CRS 812444-01-0, CRS 812444-02-0, and CRS 812444-03-0.

Descriptors: *Acid rain, *Ammonia, *Cloud liquid water, *Forests, *Nitrates, *Path of pollutants, *Sulfates, Canopy, Chemical analysis, Hydrogen ion concentration, Mountain Cloud Chemistry Project, North Carolina, Pollutant identification.

Cloudwater was simultaneously collected above and within the forest canopy during the July 1986 field intensive of the Mountain Cloud Chemistry Project near Mt. Mitchell, NC. All cloudwater was collected using the Atmospheric Science Research Center passive string collector. The most abundant ions were SO4(2-), NO3(-) and NH4(+). The pH, within and above the canopy, increased as the 24 hr back trajectory became more southerly. The average pH above and within the canopy was essentially the same, except during the middle part of the sample events when it was lower within the canopy. Most of the sampled events contained a lower pH toward their end inside the canopy than above, perhaps due to the leaching of ions, or to the smaller samples collected within the canopy. This implies that trees within the canopy shadow may experience a stress greater than that suggested by measurements made above the canopy. It is shown that trees modify their chemical environment. (See also W90-09408) (Author's abstract)
W90-09420

TRITIUM DEPOSITION OVER THE CONTINENTAL UNITED STATES, 1953-1983.

Geological Survey, Reston, VA. Water Resources Div.
R. L. Michel.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 109-115, 2 fig, 1 tab, 7 ref.

Descriptors: *Fate of pollutants, *Path of pollutants, *Tritium, Albuquerque, California, Chicago, Data acquisition, Menlo Park, New Mexico, Precipitation, Radioactive tracers, Radioactive wastes.

Tritium was produced in great quantities by atmospheric nuclear weapons testing, the majority of which occurred in the mid-1950's and early 1960's. After production, the tritium atom is incorporated in the water molecule and can be used as a tracer of hydrologic and oceanographic phenomena. A major limitation in using tritium as a tracer for hydrologic processes is the limited data on its input. Since the early 1960's the US Geological Survey has monitored tritium deposition with monthly analyses of tritium in precipitation by a network of 14 stations throughout the United States. Tritium deposition has now been calculated for this series of network stations for 1953 to 1983. For years when data were not available for a given station, estimates of tritium deposition were made

from correlations with data collected at other stations. Depositions are given in TU-meters (1 TU=1 tritium atom per 10 to the 18th power hydrogen atoms) on a cumulative basis for all stations in the network. Depositions were largest in the midwest and exceeded 7500 TU-m/sq cm at the Chicago station. Depositions were smallest in the Southwest due to either the low precipitation or the influence of moisture from the Pacific Ocean. At Menlo Park, California and Albuquerque, New Mexico depositions were about 1/5th of those found in Chicago. Approximately 60% of all deposition occurred between 1961 to 1965 and over 90% of the deposition occurred by 1970. By 1983, more than 70% of all tritium deposited at network stations from 1953 to 1983 had been removed from the environment by radioactive decay. Major peaks in deposition occurred in 1954, 1958, and 1963; a small increase in deposition from Chinese testing occurred in the late 1970's. From the network data and the data of other laboratories, a map of cumulative tritium deposition over the continental United States has been constructed for 1953 to 1983. The total tritium deposition on the continental United States was calculated to be 12 +/-2 kg during 1953 to 1983. (See also W90-09408) (Author's abstract)
W90-09421

USE OF ATMOSPHERIC TRANSPORT PATTERN RECOGNITION TECHNIQUES IN UNDERSTANDING VARIATION IN PRECIPITATION CHEMISTRY.

Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
J. L. Moody, J. A. Galusky, and J. N. Galloway.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 119-125, 4 fig, 7 ref.

Descriptors: *Acid rain, *Air pollution, *Atmospheric chemistry, *Data interpretation, *Path of pollutants, Amsterdam Island, Bermuda, Cape Point, Charlottesville, Precipitation mapping, South Africa, Virginia, Water pollution sources.

Pattern recognition was demonstrated to be a useful method for quantifying the relative importance of atmospheric transport as a factor contributing to variability in the chemical composition of precipitation at four different sampling sites: Charlottesville, VA; Cape Point, South Africa; Bermuda; and Amsterdam Island, in the central Indian Ocean. Cluster analysis was used to identify periods of similar transport defined by using back trajectories. The resulting patterns determine the relative frequency of precipitation bearing winds arriving from different regions. Significant differences in chemical composition between these transport patterns were identified. Amsterdam Island and Cape Point represent relatively clean sites where composition did not depend on transport. In contrast, at Bermuda and Charlottesville, 20% to 30% of the chemical variability appears to be related to transport. At these sites the influence of dominant source regions were clearly identified. (See also W90-09408) (Author's abstract)
W90-09422

APPLICABILITY OF PRINCIPAL COMPONENTS ANALYSIS FOR DETERMINING SOURCES OF WET DEPOSITION.

Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-09423

INFORMATION CONTENT EVALUATION FOR ACID DEPOSITION NETWORK REMEDIATION.

Waterloo Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W90-09424

Group 5B—Sources Of Pollution

REGIONAL SIMULATION OF SURFACE WATER ACIDIFICATION: UNCERTAINTY DUE TO SPECIFICATION OF ATMOSPHERIC DEPOSITION.

Virginia Univ., Charlottesville. Dept. of Environmental Sciences.

B. J. Cosby, G. M. Hornberger, and R. F. Wright.

IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 153-161, 3 fig, 1 tab, 12 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Model studies, *Norway, *Path of pollutants, *Regional analysis, *Simulation analysis, *Surface water, Air pollution, Monte Carlo method, Statistical analysis.

A regionalization methodology has been developed that uses a conceptual model of long-term water quality responses to acidic deposition in a Monte Carlo framework to simulate the observed distributions of water quality variables derived from regional water quality surveys. The regional model contains physical parameters that describe the geohydrochemical characteristics of the region, and deposition parameters which describe the magnitude and long-term temporal sequence of acidic deposition. The methodology has been applied to data from a survey of lakes in southern Norway. Sensitivity analyses of the regionally calibrated model suggest that the physical parameters are well determined and that the model is not overparameterized. The non-stationarity of the uncertainty estimates observed in the study is not surprising since the overall temporal trend of deposition is increasing over the period considered, and uncertainties appear to be greater at high levels of deposition than at low levels. The non-stationarity does, however, emphasize the need to provide estimates of the temporal variability of uncertainty when dynamic models are employed in regional analyses. Uncertainty (or sensitivity) estimates derived for the calibration period alone may not represent the actual model uncertainty when forecasts or hindcasts are being made. For this regional calibration of the Model of Acidification of Groundwater in Catchments (MAGIC) for southern Norway, it is concluded that uncertainty in the simulated distribution of water quality variables arising from deposition parameter uncertainty is of the same order as that arising from physical parameter uncertainty. Further, deposition uncertainties of the magnitude and timing considered would not be so large as to preclude resolution of historical changes in water quality in the region. Forecasts made with the calibrated regional model should provide reasonable resolution of changes that might result from future deposition reductions. (See also W90-09408) (Lantz-PTT)
W90-09426

SYSTEMATIC PARAMETER ESTIMATION STRATEGY FOR REFINING THE BIRKENES MODEL.

Purdue Univ., Lafayette, IN. School of Civil Engineering.

For primary bibliographic entry see Field 7C.
W90-09427

ATMOSPHERIC DEPOSITION OF SULFUR TO A GRANITE OUTCROP IN THE PIEDMONT OF GEORGIA, U.S.A.

Geological Survey, Doraville, GA. Water Resources Div.

N. E. Peters.

IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 173-181, 4 fig, 12 ref.

Descriptors: *Acid rain, *Georgia, *Path of pollutants, *Runoff, *Sulfates, *Water pollution sources, Air pollution, Precipitation, Rainfall-runoff relationships, Seasonal variation, Sulfur.

The quantity and quality of precipitation to and runoff from a 0.054 ha catchment on a granite

outcrop, at Panola Mountain, Georgia, were evaluated for 24 events from May 1987 through January 1988. For events that were sampled concurrently for precipitation and runoff, which excluded those in July and August, precipitation ranged from 2.4 mm to 35.6 mm and totaled 385 mm, or 70% of the precipitation for the period. The SO4(2-) in precipitation accounted for 67% of the total SO4(2-) transported in runoff. For individual events, wet deposition contributed 22% to 100% of the SO4(2-) transported in runoff. For events with the low percentage contributions, the source of the remaining SO4(2-) in the runoff was washoff of dry-deposited sulfur that had accumulated on the outcrop between events. Although wet deposition of H(+) exceeded its gross transport in runoff for all events, collectively, concentrations of H(+) and SO4(2-) in runoff for events preceded by long dry periods (several days to weeks) were much higher at the onset of the event than those in the corresponding precipitation; these concentration differences decreased as the precipitation progressed. In contrast, H(+) and SO4(2-) concentrations in runoff were similar to those in the corresponding precipitation throughout events preceded by short dry periods (typically less than a day). These events also had high percentage contributions of H(+) and SO4(2-) from wet deposition. The SO4(2-) dry deposition to the granite outcrop computed by this mass balance for the total of the dry periods preceding each event averaged 0.33 eq/ha/day. (See also W90-09408) (Author's abstract)
W90-09428

CONTRIBUTION OF ACIDIC DEPOSITION ON HIGH ELEVATION FOREST CANOPY TO THE HYDROLOGIC CYCLE.

North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.

V. K. Saxena, and N. H. Lin.

IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 193-202, 2 fig, 4 tab, 20 ref.

Descriptors: *Acid rain, *Alpine regions, *Cloud liquid water, *Forest watersheds, *Hydrologic budget, Ammonia, Chemical interactions, Coniferous forests, Fir trees, Fog, Hydrogen ion concentration, Mountains, Mt Mitchell, Nitrates, Precipitation, Spruce trees, Sulfates.

Direct capture of cloud droplets by forest canopies atop mountains in North America and Europe has been recently pointed out as a significant contributor to the hydrological cycle and to the acidic deposition flux to the forest canopy. Results of an EPA initiated field study at Mt. Mitchell, North Carolina, the highest peak east of the Mississippi River, were analyzed and rates of cloud water deposition were computed using a micrometeorological approach and database consisting of pH and chemical composition of collected cloud water, measured cloud droplet size distribution, liquid water content, and the conventional meteorological variables. The red spruce and Fraser fir stands atop Mt. Mitchell are exposed to cloud episodes during 71% of days/yr, although the cloud immersion time varies between 10-20%. Ion deposition fluxes due to direct cloud interception by the forest canopy were obtained for H(+), NH4(+), SO4(2-) and NO3(-). The rate of cloud deposition was in the range of 15-27 cm/yr. The deposition flux of sulfate ranged 26-82 kg/ha/yr, which is comparable to recently reported sulfate deposition of 23.1 kg/ha/yr due to precipitation in the eastern United States. (See also W90-09408) (Author's abstract)
W90-09430

EFFECTS OF FOREST CANOPY ON THROUGHFALL PRECIPITATION CHEMISTRY.

Swiss Federal Inst. of Forestry Research, Birmensdorf.

P. Kloeti, H. M. Keller, and M. Guecheva.

IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May

1989. IAHS Publication No. 179, 1989. p 203-209, 2 fig, 3 tab, 2 ref. Swiss National Science Foundation Project NFP14+.

Descriptors: *Acid rain, *Canopy, *Chemical interactions, *Forest watersheds, *Path of pollutants, *Precipitation, *Switzerland, *Water pollution sources, Air pollution, Alpine regions, Ammonia, Buffer capacity, Dry deposition, Leaching, Nitrates, Nitrogen, Nutrients.

In forested areas precipitation chemistry undergoes various changes as the precipitation passes through the forest canopy. These changes depend on a number of factors such as leaching from needles or leaves, dry atmospheric deposition prior to the onset of precipitation, initial chemistry of precipitation reaching the forest canopy, meteorological as well as air quality characteristics. A study was started in 1985 at three forest sites intensively instrumented in the Swiss lowlands (Laegern), pre-Alps (Alptal), and Alps (Davos), where several hundreds of samples of precipitation above and below the forest canopies were analyzed and compared with simultaneous information on meteorological and air quality parameters. Atmospheric deposition below the forest canopy at Laegern is, as a result of air pollution, considerably higher than at Davos. Rainwater quality (wet only) at Laegern is significantly lower than that at Davos, with elemental concentrations being about twice those at Davos. The proton input at Laegern is about twice that at Davos and results in significantly higher ion transport rates from the canopy to the forest floor. Acids are largely buffered in the deciduous canopy of beech trees; only small amounts reach the floor. Ion exchange processes in the canopy result in leaching losses of Ca(2+), K(+), Mg(2+) and Mn(2+). Cations leached in the canopy need to be replaced by nutrient uptake through roots and leaves in order to maintain a balanced nutrient status of the tree. Nitrogen deposition at Laegern is high, and the nutritive status of the forest stand seems not to be critical. A contrasting situation is found at Davos where NO3(-) and NH4(+) deposition is much lower and a direct uptake of these rainwater N compounds by the needles can be shown. Crystalline soil conditions with low limestone content result in a much lower buffering capacity at Davos; the long-term behavior is therefore uncertain. (See also W90-09408) (Lantz-PTT)
W90-09431

FOLIAR ABSORPTION OF 15-N LABELED NITRIC ACID VAPOR (HNO3) IN MATURE EASTERN WHITE PINE (PINUS STROBUS L).

Southeastern Forest Experiment Station, Otto, NC. Coweeta Hydrologic Lab.

J. M. Vose, W. T. Swank, R. W. Taylor, W. V. Dashek, and A. L. Williams.

IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 211-219, 1 fig, 4 tab, 17 ref. EPRI Contract RP2326-1.

Descriptors: *Acid rain effects, *Bioaccumulation, *Laboratory methods, *Leaves, *Nitric acid, *Nitrogen radioisotopes, *Path of pollutants, *Pine trees, Coniferous forests, Forests, Nitrates, Photosynthesis, Plant physiology, Scanning electron microscopy, Transpiration.

Foliage of mature white pine in cuvettes was exposed to 50 ppb 15-N labeled nitric acid vapor (H15-NO3) for 4 to 12 h to quantify foliar absorption. Net photosynthesis, transpiration, and leaf conductance were measured and foliage was observed with a scanning electron microscope (SEM). Physiological data were variable, but results indicated that transpiration and leaf conductance were reduced after exposure. Potential mechanisms include a humidity build-up within the cuvette (e.g., cuvette humidity was 7% to 20% higher than ambient conditions), and the direct effects of H15-NO3 exposure. SEM of young foliage after one exposure revealed substantial cuticular disruption, which may have enhanced 15-N movement across the cuticle. 15-N was absorbed in

all exposures, with rates ranging from 0.00925 to 0.15650 micrograms 15-N/gm foliage/exposure hr. Extrapolation to the entire canopy resulted in an estimated foliar uptake of 5.5 kg N/ha/yr. This represents approximately 10% of the annual canopy N requirement. (See also W90-09408) (Author's abstract)
W90-09432

BULK PRECIPITATION DEPOSITION OF IN-ORGANIC CHEMICALS IN FOREST AREAS AND ITS INFLUENCE ON WATER QUALITY IN THE FEDERAL REPUBLIC OF GERMANY.
Hessian Forest Research Station, Hann. Muenden (Germany, F.R.). Inst. of Forest Hydrology.
H. M. Brechtel.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 221-228, 3 tab, 12 ref.

Descriptors: *Acid rain, *Forest watersheds, *Inorganic compounds, *Path of pollutants, *Water pollution sources, *West Germany, Acid rain effects, Acidification, Aluminum, Coniferous forests, Drinking water, Leachates, Manganese, Nitrates, Protons, Seepage, Soil contamination, Springs, Spruce trees, Water pollution effects, Water quality, Zinc.

Extensive investigations about the deposition input in forests of the West Germany revealed the fact that the concentrations and deposition rates in forest stands were significantly higher than those in open fields. This was especially evident for Norway spruce. The annual proton deposition through bulk precipitation in old spruce stands at some locations reached a magnitude of 3-4 kmol/ha. This resulted in a deep reaching increased acidification in forest soil profiles. This phenomenon in turn caused the release of certain cations from the soil exchange complex and increased the elemental concentrations of leachate water substantially. In fact the annual average concentrations of manganese, aluminum and zinc in seepage water collected at a depth of 150 cm of soil profile exceeded the permissible drinking water limits with a multiplying factor of 226, 34 and 3 respectively. In case of nitrate, the concentration of leachate water at a depth of 50 cm of the soil profile was close to the drinking water limit of 50 mg/L. In some cases, the aluminum concentration in streamflow and forest springs reached similar magnitudes. (See also W90-09408) (Author's abstract)
W90-09433

LEACHING OF STRONG ACID ANIONS FROM SNOW DURING RAIN-ON-SNOW EVENTS: EVIDENCE FOR TWO COMPONENT MIXING.
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
H. G. Jones, M. Tranter, and T. D. Davies.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 239-250, 4 fig, 3 tab, 20 ref.

Descriptors: *Acid rain, *Chemical interactions, *Chemistry of precipitation, *Laboratory methods, *Leaching, *Path of pollutants, *Rain, *Snow, Artificial precipitation, Chemical reactions, Ion transport, Mixing, Rainfall rate.

The addition of artificial rain to columns of snow in controlled laboratory experiments demonstrates that solute is leached from snow by the percolating solution, even after allowing for the addition of solute by localized melting at the snow surface. Solute is scavenged when the artificial rain contains common ions. The strong positive correlation of the major strong acid anions suggests that two component mixing occurs, which involves the artificial rain and the solute-rich brines found at the ice crystal surfaces. The ionic concentrations in the leachate may vary by a factor of three, despite

experimental conditions being broadly similar. This is thought to reflect the influence of rainfall rate, rainfall temperature, and more particularly, snow column hydrology. (See also W90-09408) (Author's abstract)
W90-09435

MIXING OF ACID MELTWATER WITH GROUNDWATER IN A FORESTED BASIN IN FINLAND.
Uppsala Univ. (Sweden). Dept. of Hydrology.
L. Bengtsson, A. Lepisto, R. K. Saxena, and P. Seuna.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 251-258, 4 fig, 10 ref.

Descriptors: *Acid rain effects, *Finland, *Forest watersheds, *Path of pollutants, *Snowmelt, *Surface-groundwater relations, Acidic water, Flood peak, Groundwater movement, Hydrographs, Isotope studies, Mixing, Sulfates.

Hydrograph separation using oxygen-18 was undertaken during the snowmelt periods of 1985 and 1987 in a forested basin (0.69 sq km) in southern Finland. The degree of mixing of acid meltwater and neutral groundwater was estimated. Application of isotope techniques indicated that subsurface pre-event water is the major component of discharge even during the snowmelt period. The meltwater fraction of the total runoff during the melt periods was computed to be about 15%. During peak flow the meltwater fraction was 30-40%. The dominant mechanism in the system is the displacement of old water already in the catchment as soil water or groundwater by incoming meltwater. It seems probable that a major part of the sulfate load is passing through the unsaturated zone of the soil. Because the alkalinity of the groundwater (pre-event water) is high compared to acid precipitation (pH 4.0-4.6) characteristics of the region, groundwater discharge results in significant neutralization of stream water acidity. (See also W90-09408) (Author's abstract)
W90-09436

PESTICIDES IN TERRESTRIAL AND AQUATIC ENVIRONMENTS.
Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. 551p. Edited by Diana L. Weigmann.

Descriptors: *Aquatic environment, *Conferences, *Ecotoxicology, *Path of pollutants, *Pesticides, *Water pollution effects, Case studies, Cost-benefit analysis, Environmental protection, Groundwater pollution, Monitoring, Regulations, Risk assessment, Water pollution control.

Across the nation, public dialogues on pesticide issues are increasingly becoming polarized. The communication and exchange of statistically valid research data is essential to reach a broad consensus among groups and individuals with diverse, firmly-held opinions on pesticide use. In these proceedings, researchers from 23 states, the District of Columbia, and Canada present information on a wide range of topics: the environmental effects of pesticide use; pesticides in water supplies and wastewater sludge; pesticide waste disposal; case studies of pesticide pollution; pesticide monitoring in groundwater, surface water, and terrestrial environments; risk assessment; environmental regulations; management techniques for nonpoint surface pollution control; and cost-benefit analyses of water quality impacts. (See W90-09441 thru W90-09478) (Lantz-PTT)
W90-09440

OCCURRENCE OF ATRAZINE IN GROUND-WATER AS A RESULT OF AGRICULTURAL USE.
Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
M. R. Barrett, and W. M. Williams.

IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 39-61, 8 fig, 2 tab, 31 ref.

Descriptors: *Atrazine, *Groundwater pollution, *Herbicides, *Nonpoint pollution sources, *Path of pollutants, *Pesticides, *Triazine herbicides, *Water pollution sources, Agricultural runoff, Environmental effects, Iowa, Karst, Nebraska.

Atrazine is the most frequently detected herbicide in ground water in most corn and sorghum growing areas of the country. In certain heavy use areas such as those surrounding the Platte river in south central Nebraska (characterized by well drained permeable soils and intensive irrigation in corn production) and Floyd and Mitchell counties in Iowa (where preferential flow of pesticides in karst terrain accounts for a significant amount of the leaching), occurrence or atrazine in groundwater is widespread. The relative presence of atrazine in groundwater compared to other pesticides is a result of its persistence (in aqueous media and in soils), moderate mobility, and perhaps most significantly its widespread use. Except in conditions of very high hydrogeologic vulnerability (permeable soils, less than thirty feet to groundwater, and/or karst terrain), most atrazine concentrations in groundwater associated with normal agricultural use fall in the sub-part per billion range. Some correlations are observed by comparing monitoring county-level resolution data on atrazine use and hydrogeologic vulnerability as represented by EPA's agricultural DRASTIC rating system. However, finer resolution data on hydrogeologic vulnerability before areas in which ground water is impacted as a result of normal agricultural use can be reliably predicted. Future research must concentrate on obtaining reliable data on water well construction, agricultural practices and pesticide use, site hydrogeology and ground water contamination activities. Groundwater monitoring surveys must be planned with attention to the process of selecting wells for sampling and for sampling techniques which insures that the residue data collected represent the population of interest. (Author's abstract)
W90-09444

HERBICIDE MONITORING OF TILE DRAINAGE AND SHALLOW GROUNDWATER IN NORTHWESTERN OHIO FARM FIELDS--A CASE STUDY.
Science Applications International Corp., Denver, CO.
A. M. Keim, L. C. Ruedisili, D. B. Baker, and R. E. Gallagher.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 62-78, 7 fig, 3 tab, 11 ref.

Descriptors: *Agricultural runoff, *Groundwater pollution, *Herbicides, *Monitoring wells, *Ohio, *Path of pollutants, *Pollutant identification, *Tile drainage, Alachlor, Atrazine, Cyanazine, Metolachlor, Metribuzin.

Herbicide concentrations in groundwater and the influence of tile drains on concentrations were monitored at two northwestern Ohio farms. A twelve acre field (Ottawa County) had clayey soils and used no-till crop production while a sixteen acre site (Lucas County) had sandy soils and was under conventional tillage practices. At both sites, monitoring wells at depths of 5.5, 7.0, or 10 to 12 feet (1.7, 2.1, or 3.0 to 3.7 m) were placed next to tile drains and midway between drains. These wells were used to collect groundwater samples, determine hydraulic characteristics of the saturated zone, and measure fluctuations of the water table. Water samples were collected from tile effluent and monitoring wells at both fields from May 1987 to August 1988. Atrazine was the most frequently detected herbicide at both fields and concentrations were as high as 12.08 micrograms per liter. Maximum concentrations of alachlor, cyanazine, metolachlor, and metribuzin were 1.47, 2.50, 0.99

and 0.20 micrograms per liter respectively. Significant temporal variability of herbicide concentrations was exhibited at both sites. The greatest number and highest concentration of herbicides were detected within two months following pesticide application in 1987, when rainfall was abundant and recharging groundwater. The severe drought in 1988 resulted in little to no increase in herbicide concentrations following application. Drain tiles appeared to have little effect on median atrazine concentrations in groundwater in the sandy field, but tiles seemed to reduce the amount of atrazine leaching to groundwater in the clayey soils. (See also W90-09440) (Author's abstract) W90-09445

EFFECT OF AGRICULTURAL CHEMICALS ON GROUNDWATER QUALITY IN THE NEW JERSEY PLAIN.
New Jersey Dept. of Environmental Protection, Trenton. Office of Science and Research.
J. B. Louis, and E. Vowinkel.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989, Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 80-89, 3 fig, 6 tab, 18 ref.

Descriptors: *Agricultural chemicals, *Environmental effects, *Groundwater quality, *Herbicides, *Pesticides, *Water pollution effects, Acetanilide, Agricultural runoff, Alachlor, Aldicarb, Aquifers, Atrazine, Carbofuran, New Jersey, Nitrates, Organophosphorus pesticides, Standards, Triazines, Volatile organic compounds.

To determine whether agricultural chemicals such as pesticides and nutrients have affected the quality of groundwater in the New Jersey Coastal Plain, agricultural wells were studied in areas where ground water is susceptible to contamination. The outcrop areas of two Costal Plain aquifers: the Potomac-Raritan-Magothy and Kirkwood-Ciohansey aquifer-systems-were chosen for study. Water samples were collected from selected domestic, irrigation and public supply wells located within 800 meters of agricultural land. A total of 81 wells in seven counties were sampled during the summers of 1986 and 1987. The median depth of the wells was 26 meters. The samples were analyzed for nutrients, volatile organic fumigants, triazine, acetanilide, and chlorophenoxy acid herbicides, and carbamate, organochlorine, as well as organophosphorus insecticides. Pesticide residues were detected in water from 27 of 81 wells. Residues of 22 pesticides and three pesticide metabolites were detected in concentrations ranging from 0.01 to 13 micrograms/L. More than one pesticide was detected in groundwater from 17 wells. The most frequently detected pesticides were the metabolites of aldicarb, carbofuran, atrazine, alachlor, and chloroform. The median dissolved nitrate concentration was 5.1 mg/L as nitrogen. Dissolved nitrate concentrations exceeded the primary drinking water standard of 10 mg/l in 33% of the samples. (See also W90-09440) (Author's abstract) W90-09446

HERBICIDE CONCENTRATION PATTERNS IN RIVERS DRAINING INTENSIVELY CULTIVATED FARMLANDS OF NORTHWESTERN OHIO.
Heidelberg Coll., Tiffin, OH. Water Quality Lab.
D. B. Baker, and R. P. Richards.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989, Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 103-120, 8 fig, 2 tab, 27 ref.

Descriptors: *Agricultural runoff, *Herbicides, *Monitoring, *Nonpoint pollution sources, *Path of pollutants, *Pesticides, *Water pollution sources, Environmental effects, Hydrographs, Lake Erie basin, Nitrates, Ohio, Organic compounds, Public health, Rivers.

A long term pesticide monitoring study is underway in Lake Erie tributaries to access ecological and human health impacts of pesticide runoff from current farming practices. Peak concentrations in

rivers systems occur during runoff events following pesticide application. Frequent sampling during storm events is necessary to investigate peak concentrations, since concentrations change rapidly during events. The concentrations of major herbicides parallel one and other, with peak concentrations generally coinciding. Absolute concentrations of different pesticides vary in proportion to their use as well as other specific characteristics such as persistence of the individual compounds. The pattern of pesticide concentration during storm events is distinct from both sediment and nitrate patterns. Sediment concentrations peak early during hydrographs, pesticides have a relatively broad peak during the middle portion of hydrographs, while nitrates peak late during hydrographs. There is a large year to year variability in pesticide concentrations as loads, due to variations in rainfall timing, intensity and amounts. The position of the sampling station within the drainage network strongly influences the concentration patterns. As watershed size increases, peak pesticide concentrations decrease but the durations of exposure to intermediate concentrations increase. Peak concentrations of several herbicides exceed 100 micrograms/L in small streams in some years. (See also W90-09440) (Author's abstract) W90-09448

ENHANCED DEGRADATION OF CARBAMOTHIOATE HERBICIDES IN HISTORY SOILS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Plant Pathology, Physiology and Weed Science.
K. K. Hatzios, S. A. Meredith, V. K. Stromberg, and G. H. Lacy.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 143-153, 2 fig, 4 tab, 33 ref. USDA Grant 85-CRCR-1-1905.

Descriptors: *Biodegradation, *Carbamothioate herbicides, *Fate of pollutants, *Herbicides, *Path of pollutants, *Soil contamination, Bacteria, Biological treatment, Butylate, Corn, EPTC, Soil bacteria, Soil treatment.

Studies monitoring the evolution of CO_2 in soil biometer flasks showed that the rate of degradation of the carbamothioate herbicide EPTC (S-ethyl dipropylcarbamothioate) in soils exposed to three successive annual applications of the carbamothioate herbicide butylate (S-ethyl bis(2-methylpropyl) carbamothioate) was much greater than in control soils. Sterilization of the control and history soils resulted in a significant reduction of the EPTC degradation rate in both soils confirming the involvement of soil microorganisms in the degradation of this herbicide. The rate of EPTC degradation in history soils planted with corn (Zea mays L.) was slower than that of history soils without corn indicating the potential involvement of the rhizosphere effect in the degradation of this herbicide. Several strains of soil bacteria, mainly fluorescent pseudodomonads, were isolated from control and history soils. Many of these stains were capable of growing on a minimum salt medium containing the herbicide EPTC as the soil source of carbon. Electrophoretic analysis of cell lysates of bacterial isolates from control or history soils revealed the detection of two plasmids of 2.0 and 9,0 kb, respectively. These plasmids were unstable and were lost spontaneously following cold storage (5 C) of these bacterial strains. (See also W90-09440) (Author's abstract) W90-09451

DEGRADATION OF TERBUFOS IN SOILS DURING DROUGHT CONDITIONS.
Clemson Univ., SC. Inst. of Wildlife and Environmental Toxicology.
G. C. Cobb, L. W. Brewer, and R. J. Kendall.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 159-170, 5 fig, 6 tab, 15 ref.

Descriptors: *Degradation, *Drought, *Fate of pollutants, *Organophosphorus pesticides, *Path of pollutants, *Soil water, *Terbufos, Iowa, Pesticides, Water deficit.

Soil concentrations of terbufos and several of its metabolites were measured for sixty four days after application of COUNTER to corn crops. Both banded and in furrow treatments were monitored. During corn planting, the major pest control product is COUNTER 15G. This organophosphate pesticide formulation contains the active ingredient terbufos (a phosphorodithioate compound). Soil moisture was quite low during the study period. Normal soil moisture in south-central Iowa is 30%, but this study indicated an average of 14.2% during the sixty-four day period after application. All samples analyzed in this study were greater than one gram. Drought conditions were experienced during the study that give special significance to this data. The information presented indicates that terbufos degradation under dry conditions is little different from degradation under more common conditions. (See also W90-09440) (Lantz-PTT) W90-09452

EPA SUPERFUND DATA BASES ON THE OCCURRENCE AND DISTRIBUTION OF ORGANOCHLORINE PESTICIDES IN WATERS AND SOILS FROM HAZARDOUS WASTE SITES.
Viar and Co., Alexandria, VA.
For primary bibliographic entry see Field 7C.
W90-09453

REGIONAL ASSESSMENT OF PESTICIDE EXPOSURE USING STORET DATA.
George Mason Univ., Fairfax, VA. Dept. of Biology.
For primary bibliographic entry see Field 7C.
W90-09454

NEW JERSEY PESTICIDE USE SURVEY.
New Jersey Dept. of Environmental Protection, Trenton. Office of Science and Research.
J. B. Louis, M. G. Robson, and G. C. Hamilton.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 194-204, 5 fig, 4 tab, 11 ref.

Descriptors: *Agricultural runoff, *Data acquisition, *New Jersey, *Pesticides, *Regulations, *Surveys, *Water pollution sources, Agricultural chemicals, Agricultural practices, Aquifers, Databases.

In 1986, New Jersey's Pesticide Control Program (PCP) undertook a major survey of agricultural applicators in New Jersey. New Jersey's pesticide regulations require certified applicators to maintain records of pesticide use and to submit that information to the New Jersey Department of Environmental Protection (NJDEP) upon request. A survey was developed and submitted to the certified pest applicators in the agricultural community. Information requested by the survey included: the pesticide(s) used, the number of acres treated, the crop treated, the method of application and the municipality where the pesticide was applied. A total of 176 active ingredients were reported. A total of 1,579,284 lbs. of active ingredients was applied by 1721 separate farming operations in New Jersey in 1985. The data from this survey were summarized and entered into a geographic information system (GIS). Using the mapping capabilities of GIS, quantitative descriptions of the locations of pesticide applications in relation to areas where there are vulnerable aquifer systems, portable water intakes, endangered species, or other environmental concerns can be obtained. This capability is particularly useful in reviewing applications for specialized pesticide use as well as in imposing restrictions on certain pesticides in areas where problems are likely to occur. In addition, the data are currently being used by the U.S. Geological Survey in planning projects to monitor

pesticide residues in both ground and surface water. Because of the usefulness of this data, the survey will be repeated every three years. (See also W90-09440) (Author's abstract)
W90-09455

PESTICIDES IN RUNOFF FROM FORESTED LANDS IN THE SOUTHEAST.
Georgia Univ., Athens. Cooperative Extension Service.
P. B. Bush, J. F. Dowd, A. G. Williams, D. G. Neary, and J. Taylor.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 207-213, 6 ref.

Descriptors: *Forest watersheds, *Path of pollutants, *Pesticides, *Water pollution sources, Flow profiles, Forest hydrology, Forestry, Runoff, Soil water, Southeastern United States.

The movement of pesticides within a forested watershed is influenced by three factors: the dominant hydrologic flow processes, the application method and location within the watershed, and the chemical properties of the pesticide. Pesticides that are insoluble or sorb strongly to organics or the soil will be relatively immobile in forestry applications. Very soluble and weakly sorbing pesticides may be relatively mobile. Aerial application usually has more potential for causing pesticides in runoff because of the chance for application on to variable source areas (transiently saturated zones that generate stream flow). Application to the stems of trees provides opportunity for transport because of stem flow. Stemflow could also cause enhanced runoff of pesticides applied at the base of trees. Location of the application in the water shed is a very important factor in determining the potential for pesticides appearing in runoff; most pesticides applied in variable source areas will appear in runoff. Pesticides applied to zones some distance from the source areas are important when active macropores exist. The interaction of these factors on pesticide movement is illustrated by field studies of forested sites in the mountain and piedmont provinces of the southeast. (See also W90-09440) (Author's abstract)
W90-09456

QUANTITATION OF NONPOINT SOURCE POLLUTION ASSOCIATED WITH CRANBERRY PRODUCTION IN MASSACHUSETTS.
Massachusetts Agricultural Experiment Station, East Wareham.
K. H. Deubert, and G. Z. Kaczmarek.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 214-219, 1 fig, 4 tab, 5 ref.

Descriptors: *Agricultural runoff, *Cranberries, *Massachusetts, *Nonpoint pollution sources, *Parathion, *Path of pollutants, *Water pollution sources, Agricultural chemicals, Bogs, Organophosphorus pesticides, Pesticides.

Monitoring studies (conducted for two years) on parathion, and laboratory studies using water from the field, were used to establish a database suitable to draw first conclusions. More than 90 percent of the break down in ditch water takes place during the first two to four days after an application, while the water is impounded. Parathion levels in bog effluents (0.11 to 5.8 ppb; mean 1.12 ppb) decreased slightly (0.21 to 0.93 ppb; mean 0.39 ppb) before they left the watershed. Under the conditions of this study, approximately 45.8g/day sorbed parathion was discharged by a watershed. Low residue levels require accurate analytical work to arrive at a meaningful conclusion. Even at the low levels encountered in this study, parathion residue ranges can be used to quantitate nonpoint source pollution. Residue amounts were too small to determine the effects of environmental factors on residue amounts in the field. Laboratory studies using water from the field showed that microorganisms and sedimentation are the most important

factors determining the amounts of sorbed parathion. Research is needed to verify the conclusions by means of field studies. (See also W90-09440) (Author's abstract)
W90-09457

COPPER, CHROMIUM, ARSENIC AND PENTACHLOROPHENOL CONTAMINATION OF A SOUTHERN APPALACHIAN FOREST STREAM.
Southeastern Forest Experiment Station, Gainesville, FL.
D. G. Neary, P. B. Bush, R. A. Lafayette, M. A. Callahan, and J. W. Taylor.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 220-236, 8 fig, 2 tab, 21 ref.

Descriptors: *Arsenic, *Chromium, *Copper, *Forest watersheds, *Path of pollutants, *Pentachlorophenol, *Wood preservatives, Florida, Industrial wastewater, Storm runoff, Streams.

Storm runoff from a wood-preservative plant transported copper (Cu), chromium (Cr), arsenic (As), and pentachlorophenol (PCP) into the headwaters of a southern Appalachian stream which drains into a major recreational lake on the Chattahoochee National Forest in northern Georgia. The stream system was sampled along a 5-km longitudinal gradient which included reaches characterized by pools and riffles, sandy bottoms, beaver ponds, artificial ponds, lakes and deltas. Stream-bottom, pond and deltaic sediments and stream flow were collected for one year to determine seasonal levels, vertical and horizontal distributions in the system, and important transport processes. Pentachlorophenol levels were low (1 to 3 mg/kg) in coarse stream-bottom sediments, and high (10 to 20 mg/kg) on fine textured bottom muds. In stream flow, PCP frequently exceeded the USEPA standard (1 mg/cu m), peaked at 365 mg/cu m, and was detectable at low concentrations (1 to 8 mg/cu m) for long distances down stream. Copper, Cr and As levels followed the same pattern as PCP, but were generally lower. Pentachlorophenol, Cu, Cr, and As were transient in normal stream reaches and accumulated in pond and deltaic sediments. (See also W90-09440) (Author's abstract)
W90-09458

ORGANOPHOSPHATE ACID ANHYDRASES, HYDROLYTIC ENZYMES FOR ORGANOPHOSPHATE DETOXIFICATION.
Aberdeen Research and Development Center, Aberdeen Proving Ground, MD.
W. G. Landis, N. A. Chester, H. D. Durst, A. J. Mueller, and D. P. Dumas.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 270-283, 3 fig, 2 tab, 30 ref.

Descriptors: *Biodegradation, *Detoxification, *Enzymes, *Fate of pollutants, *Organophosphorus compounds, *Pesticides, Anhydrases, Bacteria, Biochemistry, Clams, Hydrolysis, Protozoa.

In the last several years there has been a rapid increase in understanding with regard to a group of enzymes collectively called organophosphate acid anhydrases (OPA anhydrases). A family of enzymes in the protozoan Tetrahymena thermophila, clams (Rangia cuneata and Mercinera mercineria), and bacteria have been identified that hydrolyze materials such as pesticides parathion, coumaphos, diazinon, and mipafox, as well as the mammalian acetylcholinesterase inhibitors diisopropylfluorophosphate (DFP) and the closely related materials soman and sarin. The classic case of such an enzymatic system for detoxification in eucaryotes are the phylogenetically widespread glutathione S-transferases. These enzymes have the ability to conjugate and subsequently detoxify a wide variety of substrates. One of the most important discoveries has been the diversity of these enzymes and their varying substrate specificities. The OPA anhydrase derived from the bacteria

Psuedomonas has an overlapping but not identical substrate specificity to the enzymes derived from the protozoan Tetrahymena. The pesticide mipafox is a potent inhibitor of the usual OPA anhydrases, but is itself rapidly hydrolyzed by a unique OPA anhydrase found in Rangia cuneata. The use of newly synthesized organophosphorus compounds is providing the opportunity to analyze the active site capacity of these enzymes for comparative purposes. (See also W90-09440) (Lantz-PTT)
W90-09463

ENVIRONMENTAL MONITORING PROGRAMS OF THE U.S. FISH AND WILDLIFE SERVICE.
Fish and Wildlife Service, Washington, DC. Div. of Environmental Contaminants.
For primary bibliographic entry see Field 5A.
W90-09464

MOVEMENT OF ATRAZINE BY WATER FROM APPLICATION SITES IN CONVENTIONAL AND NO-TILLAGE CORN PRODUCTION.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Plant Pathology, Physiology and Weed Science.
C. L. Foy, and H. Hiranpradit.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 355-377, 4 fig, 6 tab, 44 ref, Virginia Water Resources Center Project A-046-VA.

Descriptors: *Agricultural runoff, *Atrazine, *Fate of pollutants, *No-till cultivation, *Path of pollutants, *Pesticides, Agricultural chemicals, Bioaccumulation, Corn, Plants, Sediment contamination.

Field studies on the migration and degradative disappearance of atrazine (4.5 kg/ha) from corn plots were conducted. First, atrazine loss with runoff water was induced by sprinkler irrigation. Actual surface runoff occurred in all conventionally planted plots when approximately 3.5 cm of water were applied. Average atrazine concentration in runoff water induced by sprinkler irrigation was 1.77ppm from conventionally planted, treated plots and 0.41 ppm from no-tillage, treated plots. Atrazine losses with runoff water were 1.7% of the applied amount for conventional tillage and 0.5% for no tillage. Conventionally planted, treated plots, average atrazine concentration in runoff induced by nine rains ranged from 0.16 to 0.58 ppm. These nine rains induced a total loss of 3.9% of the dosage applied. No such runoff occurred in the no tillage plots. Average concentration of atrazine detected in eroded sediment induced by each of the nine rains averaged from 0.15 to 0.86 ppm, with the total atrazine loss with eroded sediment being 0.13% of the doseage applied. No atrazine was detected in samples collected from untreated plots; however, appreciable amounts of atrazine were detected in samples collected from treated plots for both the conventional and no tillage practices at all soil depths. In conventionally planted plots, atrazine concentrations of 0.045, 0.041, 0.038, and 0.033 ppm were detected at 0 to 20.3, 20.3 to 40.6, 40.6 to 61.0 and 61.0 to 81.3 cm depths, respectively. In no-tillage plots, respective concentrations of 0.017, 0.025, 0.011, and 0.012 ppm were detected at 0 to 20.3, 20.3 to 40.6, 40.6 to 61.0, and 81.3 cm depths. Overall, the no tillage practices gave the higher yields and greatly minimized runoff of herbicidal chemical as well as eroded sediment. Surface runoff was reduced to a minimum or almost none at all when the crops were large enough to produce a canopy and mulching effect over the entire cropping area. (See also W90-09440) (Author's abstract)
W90-09466

MOVEMENT OF TRIAZINE HERBICIDES IN CONVENTIONAL AND CONSERVATIVE TILLAGE SYSTEMS.
Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.
K. W. Sander, W. W. Witt, and M. Barrett.

Group 5B—Sources Of Pollution

IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 378-382, 3 tab, 6 ref.

Descriptors: *Agricultural runoff, *Herbicides, *No-till cultivation, *Path of pollutants, *Tillage, *Triazine herbicides, Agricultural chemicals, Agricultural practices, Atrazine, Cyanazine, Groundwater movement, Groundwater pollution, Kentucky, Simazine, Soil contamination, Soil water.

Shallow soils with underlying limestone comprise most of the corn producing areas of Kentucky, consequently there is a greater tendency toward surface and groundwater sources becoming vulnerable to contamination by agricultural chemicals. Studies were initiated to determine the effect of three tillage systems on the movement of atrazine, cyanazine, and simazine off the site of application via surface runoff water and sediment as well as through the soil profile to a depth of one meter. Conventional, reduced (chisel plow), and no-tillage systems were evaluated. Conventional tillage resulted in the highest amount of water and sediment runoff in both years of the study. Reduced tillage resulted in the highest amount of water in 1986 to 1987. A rainfall event received within one day after triazine application in 1986 accounted for 90, 92 and 76% of the total seasonal loss of atrazine, cyanazine, and simazine, respectively, through surface runoff. The amount of cyanazine detected in runoff water was greater than simazine; however, no differences among triazines existed when the amount of triazine loss was expressed as a percentage of the amount initially applied to the plots. Less rainfall and more intense storms characterized the 1987-88 growing season compared to the 1986-87 growing season. High intensity storms occurring within one month after triazine application in 1987 caused a 96% seasonal loss of atrazine; a 95% loss of cyanazine, and a 96% loss of simazine, through surface runoff. Conventional tillage had the greatest amount of triazine loss in runoff water. The amount of simazine detected in runoff water was greater than cyanazine. Triazine concentration in the soil surface differed among tillages in 1986 and follow the order: conventional > reduced > no-till. Triazine concentrations in the top 20 cm of the soil profile 150 days after application in 1986 followed the order: simazine > atrazine > cyanazine. Cyanazine was not detected in the top 20 cm of the soil profile at 150 days after application. No triazines were detected below soil depth of 20 cm at 150 days after application in 1986. (See also W90-09467) (Author's abstract)
W90-09467

RUNOFF LOSSES OF TWO TRIAZINE HERBICIDES AND METACHLOR FROM CONVENTIONAL AND NO-TILL PLOTS AS INFLUENCED BY SLUDGE.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Plant Pathology, Physiology and Weed Science.
C. L. Foy, J. S. Wilson, S. Mostaghimi, and R. W. Young.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 383-398, 5 fig, 5 tab, 31 ref, USDA Prime Grants 87-CSRS-2-2978 and 88-34050-3359.

Descriptors: *Agricultural runoff, *Herbicides, *Metachlor, *Path of pollutants, *Tillage, *Triazine herbicides, Agricultural practices, Atrazine, No-till cultivation, Simazine, Wastewater irrigation.

A rainfall simulator was used to determine the losses of atrazine, simazine, and metachlor applied at rates 1.8, 1.8, and 2.2 kg/ha, respectively, from 16 previously established no tillage and conventional tillage plots. Sewage sludge at 0, 5.8, and 11.6 Mg/ha was applied following the application of herbicides. The herbicides and sludge were either soil-incorporated or surface-applied in conventional plots. Three simulated rainfall events were applied over a two day period at an intensity of 45 mm/hour. The first event on day one lasted

one hour whereas the second and third events on day two lasted thirty minutes each. Runoff water samples were collected from plot discharges at 6 minute intervals (day 1) and 6 and 9 minute intervals (day 2). Samples were extracted using methylene chloride and quantified using gas chromatography. More runoff of water and sediment occurred and total herbicide losses for all herbicides were greater in conventional plots than in no-till plots. Concentrations of the triazine herbicides in the runoff water were higher in no-till than in conventional plot samples from the first and second rainfall events. Concentrations of metolachlor from the first event were higher in conventional surface treated plots than in no-till plots, whereas concentrations from the second and third events were basically equal in all plots. Incorporation of the herbicides into the soil reduced losses from all rainfall events. This may be attributed, in part, to the addition of sewage sludge which served as an absorbent and reduced herbicide concentrations in the runoff water. (See also W90-09440) (Author's abstract)
W90-09468

IMPACT OF CONSERVATION TILLAGE AND PESTICIDE USE ON WATER QUALITY: RESEARCH NEEDS.
North Carolina State Univ., Raleigh. Dept. of Biological and Agricultural Engineering.
For primary bibliographic entry see Field 4C.
W90-09469

INFLUENCE OF IRRIGATION AND RAINFALL ON THE MOVEMENT OF INSECTICIDES THROUGH A SANDY LOAM SOIL.
North Dakota Agricultural Experiment Station, Fargo. Dept. of Soil Science.
R. L. Kolberg, M. J. Weiss, L. D. Prunty, and J. R. Fleeker.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 447-456, 3 fig, 5 tab, 14 ref.

Descriptors: *Insecticides, *Irrigation water, *Loam, *Path of pollutants, *Pesticide residues, *Rainfall, *Sand, *Soil water, Carbofuran, North Dakota, Soil contamination, Terbufos.

Carbofuran and terbufos were applied to a system of four lysimeters in southeastern North Dakota. Insecticides were applied to the corn seed furrow approximately 3 cm above the seed during 1987 and 1988. Irrigation rates used allowed 30% and 70% depletion of available soil water. Water samples were collected from the bottom tile drains of the lysimeters (2.3 m depth) starting at planting time and continuing every two weeks thereafter. Water was also collected from vacuum extractors (1.4 or 1.8 m depths) as it became available. The parent compounds and two metabolites of each insecticide were extracted from the water samples. Soil samples were also collected (25 cm depth) in the fall of 1987 and 1988, extracted, and analyzed for the compounds and metabolites. Pesticide residues were not detected in the 1987 water samples at a detection limit of 4 ppb. In 1988, 8 ppb of carbofuran was detected in one sample collected 93 days after application from the tile drain of a lysimeter receiving the high rate of irrigation. Compounds found in the soil samples were only residues of terbufos. (See also W90-09440) (Author's abstract)
W90-09471

DEVELOPMENT OF A METHOD FOR DEFINING THE VARIABILITY IN PESTICIDE CONTAMINATION OF GROUNDWATER.
Geraghty and Miller, Inc., Tulsa, OK.
B. T. Daniels, and W. F. McTernan.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 457-471, 7 fig, 4 tab, 19 ref.

Descriptors: *Groundwater pollution, *Path of pollutants, *Pesticides, *Risk assessment, Ground-

water quality, Leaching, Monitoring, Monte Carlo method, Oklahoma, Public health, Soil properties, Statistical analysis, Water quality.

In order to assess groundwater contamination from pesticides, a method was developed and applied to a large section of Oklahoma. The method, which is titled the Pesticide Risk Index, utilized the DRASTIC Index along with pertinent data defining Oklahoma's hydrogeological and agricultural conditions to identify areas with the potential for contamination. The probability and extent of leaching for various soil and pesticide combinations found in Oklahoma were defined with a Monte Carlo analysis of 540 years of simulated field conditions using the Pesticide Root Zone Model (PRZM). The risk of human exposure to contaminated sources of drinking water was assessed by consideration of the EPA's Reference Doses for selected pesticides and the groundwater usage statistics for Oklahoma. The index resulted in a series of maps that identified the locations of greatest relative susceptibility. The pesticide Risk Index identified three areas of Oklahoma with potentially high risk for exposure to pesticide-contaminated ground water. The Monte Carlo analysis indicated that certain site and chemical parings could result in significant leaching. It was found that soil retardance was the most determinant factor in the leaching of pesticides. (See also W90-09440) (Author's abstract)
W90-09472

SIMPLIFIED PC-BASED PROCESS-ORIENTED MODEL FOR EVALUATING GROUNDWATER CONTAMINATION POTENTIAL BY PESTICIDES.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
U. Tim, and S. Mostaghimi.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 472-490, 7 fig, 4 tab, 34 ref.

Descriptors: *Computer models, *Groundwater pollution, *Groundwater quality, *Path of pollutants, *Pesticides, Aldicarb, Carbofuran, Data collections, Dicamba, Galerkin method, Groundwater movement, Kinetics, Mathematical models, Solute transport, Virginia.

A process-oriented physical based mathematical model for evaluating the subsurface fate and transport of pesticides, and for assessing the potential of a pesticide to intrude into groundwater is described. Expressions describing the simultaneous flow of water and transport and transformation of pesticides under site-specific environmental conditions were assembled and solved numerically using the Galerkin's weighted residual finite element technique. The results obtained were used to rank 16 pesticides according to their potential to contaminate groundwater. Pesticides with low aqueous solubilities, low organic carbon partion coefficients, and long soil half-lives were shown to have the highest groundwater pollution potential. In general, pesticides predicted to show significant pollution threats to groundwater include aldicarb, carbofuran, dicamba, dibromochloropropane, and ethylene dibromide. These pesticides have been detected in the groundwater of several states including Virginia. The lack of comprehensive data bases on pesticide transport currently limits the comparison of model predictions against field observations. Experimental data is needed to assess the validity of the assumptions of the model and to verify the model predictions. (See also W90-09440) (Lantz-PTT)
W90-09473

MODELING AND MEASUREMENT OF TEBUTHIURON (SPIKE) MOBILITY IN INTERMOUNTAIN SOILS.
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
G. D. Summit, R. R. Dupont, R. D. R. Parke, and H. M. Deer.
IN: Pesticides in Terrestrial and Aquatic Environ-

ments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 491-500, 4 fig, 17 ref.

Descriptors: *Model studies, *Path of pollutants, *Soil contamination, *Tebuthiuron, Aeration zone, Herbicides, Mathematical models, Mountains, Organic compounds, Range management.

Tebuthiuron (SPIKE) is widely used for the control of undesirable woody shrubs on rangelands in the Intermountain West. This herbicide is more water soluble than most herbicides, and is currently on the EPA'S list of leachable pesticides. While the manufacturer of tebuthiuron indicates that it does not move greater than 2 feet in a three year period, detectable levels of tebuthiuron at a soil depth of 18 to 24 inches only 5 months after its application. No investigators have evaluated tebuthiuron mobility below 2 feet or after a time period of more than one year. Three field sites were identified where known tebuthiuron applications were made over the past eight years. Soil cores, to at least three feet, were collected and composited in 6 to 12 inch lifts at three application at each application site. Tebuthiuron concentrations in each composite sample were quantified via HPLC analysis following Tissuemizer extraction/Kuderna-Danish concentration procedures. Two mathematical models were used to aid in the evaluation of the field data collected in this study. Both models have been designed to provide estimates of the fate and persistence of organic contaminants in the vadose zone, but differ significantly in their conceptual development, input requirements, and output provided. (See also W90-09440) (Author's abstract)
W90-09474

PREFERENTIAL FLOW THROUGH MACROPORES: TILLAGE IMPLICATIONS.
Illinois Univ. at Urbana-Champaign. Dept. of Agronomy.
T. J. Bicki, and L. Guo.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 501-514, 3 fig, 6 tab, 72 ref, Illinois Agricultural Experiment Station, Hatch Project 337.

Descriptors: *Macropores, *Path of pollutants, *Pesticides, *Soil contamination, *Tillage, Agricultural chemicals, Agricultural practices, Dye releases, Groundwater pollution, Leaching, Soil physical properties, Soil water.

Preferential flow through macropores has been identified as a possible mechanism to explain contamination of groundwater from normal application of agricultural chemicals. Soil physical property characterization, hydraulic conductivity, and bromide and dye tracer studies revealed that adoption of such conservation tillage practices as chisel plowing, disking, and para-tilling would not have any more adverse effect on groundwater quality than moldboard plowing. Under low-intensity simulated rainfall, bromide leaching is a well-structured, Flanagan silt loam was not significantly different with moldboard plow, chisel plow, disk, para-till, and no-till. Under high intensity simulated rainfall, significantly higher bromide leaching occurred in a well structured soil managed under no-till. Bromide and fluorescein dye were detected in the soil to a depth of one meter when less than one pore volume of water was applied to the no-till soil. (See also W90-09440) (Author's abstract)
W90-09475

METHOD OF VERTICAL CONCENTRATION PROFILING IN AQUIFERS CONTAMINATED BY DNAPL.
C-E Environmental, Inc., Portland, ME.
T. W. Taylor, and R. A. Lewis.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 9-24, 7 fig, 2 tab, 4 ref.

Descriptors: *Aquifers, *Data acquisition, *Dense non-aqueous phase liquids, *Groundwater pollution, *Path of pollutants, *Vertical distribution, Drilling, Hydraulic gradient, Trichloroethene, Water sampling.

Recent literature has made the geohydrologist keenly aware of the problems inherent in characterizing dense, non-aqueous phase liquid (DNAPL) contaminant distributions in aquifers. Because it is denser than water, concentrated DNAPL may sink into an aquifer of suitably high hydraulic conductivity and migrate along the surface of confining units in response to gravity gradients that do not necessarily coincide with hydraulic gradients. Although plumes of solubilized DNAPL can be defined in the groundwater, residual free product within the soil matrix is the primary problem for long-term groundwater impact and effectiveness of remediation. The screened-auger method of drilling, sampling, and monitoring well construction was used to characterize contaminant distribution and optimize well-screen placement in a large sandy aquifer. Trichloroethene (TCE) concentrations up to 200 mg/L were analyzed in screened-auger samples obtained at depths up to 100 feet below the groundwater table. When TCE is present in groundwater at more than 10% of its solubility, it strongly suggests that DNAPL exists in the aquifer as free product. The presence of residual DNAPL deep within the aquifer was not anticipated. Without representative groundwater samples obtained with the screened auger during boring advancement, the residuals may have gone undetected. With the careful interpretation of field data, the screened-auger method was effective for identifying DNAPL in an aquifer, and for providing important information for monitoring well construction and the future evaluation of remedial alternatives. (See also W90-09479) (Author's abstract)
W90-09481

USE OF SOIL GAS INVESTIGATIONS TO DETECT GROUNDWATER AND SOIL CONTAMINATION.
Tracer Research Corp., Tucson, AZ.
For primary bibliographic entry see Field 5A.
W90-09484

DETERMINATION OF FREE CYANIDE LEVELS IN SURFACE AND GROUND WATERS AFFECTED BY HIGHWAY SALT STORAGE FACILITIES IN MAINE.
Maine Dept. of Transportation, Augusta.
For primary bibliographic entry see Field 5A.
W90-09485

RESULTS OF ON-GOING MONITORING OF THE PERFORMANCE OF A LOW PERMEABILITY CLAY LINER, KEELE VALLEY LANDFILL, MAPLE ONTARIO.
Golder Associates, Mississauga (Ontario).
D. W. Reades, K. S. King, E. Benda, R. M. Quigley, and K. LeSarge.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 79-91, 7 fig, 2 tab, 4 ref.

Descriptors: *Clay liners, *Keele Valley Landfill, *Landfills, *Monitoring, *Path of pollutants, *Permeability, *Water pollution control, Diffusion, Hydraulic conductivity, Ontario.

The Keele Valley Landfill at Maple, Ontario, consists of a 99 ha (245 acres) facility designed to serve the Metropolitan Toronto area. The land-fill is located in a former sand and gravel pit, with the base and the sides of the pit lined with at least 1.2 m of low plasticity clay till compacted to achieve the required hydraulic conductivity equivalent to 0.1 n/sec or less. A comprehensive program was instituted to monitor the in situ performance of the clay till liner since construction was initiated in 1983. Results to date indicate that the liner is performing better than a 1.2 m liner with a hydraulic conductivity < 0.1 nm/sec. This is based on the hydraulic conductivity of the thin section of clay

liner above the shallow lysimeters and the results from the majority of conductivity sensor sets. Diffusion profiles from sections of the liner indicate that the rate of contamination migration into the liner is governed by diffusion. (See also W90-09479) (Lantz-PTT)
W90-09486

IMPACTS OF FORMER COAL GASIFICATION PLANTS IN A NUMBER OF HYDROGEOLOGIC ENVIRONMENTS.
Canviro Consultants Ltd., Waterloo (Ontario).
For primary bibliographic entry see Field 4C.
W90-09490

BIOTRANSFORMATION OF BTEX UNDER ANAEROBIC DENITRIFYING CONDITIONS: EVALUATION OF FIELD OBSERVATIONS.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
For primary bibliographic entry see Field 5G.
W90-09495

ALTERNATIVE TO LONG-TERM SHUT-DOWN OF A MUNICIPAL WELL IN A SAND-AND-GRAVEL AQUIFER CONTAMINATED BY CYANIDE WASTES, SOUTHERN NEW HAMPSHIRE.
Whitman and Howard, Inc., Wellesley, MA.
For primary bibliographic entry see Field 4B.
W90-09498

BEHAVIOUR OF DENSE, NON-AQUEOUS PHASE LIQUIDS (DNAPLS) IN FRACTURED MEDIA.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
B. H. Kueper, and D. B. McWhorter.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 423-434, 11 fig, 3 ref.

Descriptors: *Dense non-aqueous phase liquids, *Geohydrology, *Geologic fractures, *Groundwater movement, *Path of pollutants, Capillary water, Flow velocity, Groundwater pollution, Hydraulic gradient.

A dense, non-aqueous phase liquid (DNAPL) will enter an initially water saturated fracture provided that the capillary pressure conditions immediately above the fracture exceed the entry pressure of the fracture. The entry pressure of the fracture is a function of the fracture aperture as well as the interfacial tension between the DNAPL and water. The capillary pressure above a fracture can be expressed as a height of DNAPL pooled and is a function of DNAPL density. Alternatively, the capillary pressure conditions immediately above a fracture can be determined given knowledge of DNAPL saturation, and the appropriate capillary pressure-saturation curve for the porous media immediately above the fracture. Once having invaded a fracture, DNAPL will occupy the larger aperture pathways displacing water both upward and downward from the advancing DNAPL front. The rate of DNAPL migration through a fracture is extremely sensitive to fracture aperture and is dependent upon the DNAPL physical properties as well as the capillary pressure conditions at the top of the fracture. Downward gradients will accelerate the rate of DNAPL migration through a fracture while upward gradients will slow the rate of DNAPL migration. Upward gradients can also completely arrest the downward flow of DNAPL if the effect of gravity driving forces are overcome. (See also W90-09479) (Lantz-PTT)
W90-09509

PERMEABILITY OF FRACTURED ROCKS IN A QUARRY PROPOSED TO BE A SANITARY LANDFILL.
Waterloo Geoscience Consultants Ltd. (Ontario).
For primary bibliographic entry see Field 2F.
W90-09510

5C. Effects Of Pollution

CONTAMINANTS IN FOODS OF AQUATIC BIRDS AT KESTERSON RESERVOIR, CALIFORNIA, 1985.
Patuxent Wildlife Research Center, Laurel, MD.
For primary bibliographic entry see Field 5B.
W90-08644

SELENIUM ACCUMULATION BY RACCOONS EXPOSED TO IRRIGATION DRAINWATER AT KESTERSON NATIONAL WILDLIFE REFUGE, CALIFORNIA, 1986.
Patuxent Wildlife Research Center, Laurel, MD.
For primary bibliographic entry see Field 5B.
W90-08645

EFFECTS OF ELEVATED FOODBORNE SELENIUM ON GROWTH AND REPRODUCTION OF THE FATHEAD MINNOW (PIMEPHALES PROMELAS).
California Univ., Davis. Dept. of Land, Air and Water Resources.
R. S. Ogle, and A. W. Knight.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 6, p 795-803, November 1989. 6 tab, 43 ref. Univ. of CA Salinity/Drainage Task Force Project 86-9, and Geological Survey Project 140800001G.

Descriptors: *Fathead minnows, *Fish growth, *Selenium, *Spawning, *Toxicity, *Water pollution effects, Bioaccumulation, Bioassay, Ecological effects, Fertility, Fish food, Fish populations, Heavy metals, Morbidity, Selenium compounds, Sublethal effects.

Several field studies of selenium-contaminated lakes and reservoirs have indicated the possibility of selenium-induced reproductive failure in important populations of fish. These investigators have hypothesized that bioaccumulation of selenium through the food chain led to fish selenium levels high enough to elicit toxic responses. The present investigation was designed to determine the effects of elevated foodborne selenium on the fathead minnow (Pimephales promelas). Fish were fed a diet spiked with a mixture of inorganic (selenite and selenate) and organic (seleno-L-methionine) selenium and effects on growth and reproduction were determined. Growth was significantly inhibited at the highest selenium treatment levels evaluated (20 and 30 mg/kg Se). There were no significant treatment effects on any of the reproductive parameters measured. Reasons for the disparity between selenium-induced reproductive impairment observed in other species and apparent lack of impairment in fathead minnows may involve reduced bioaccumulation of selenium by minnows due to differences in gut morphology and physiology. (Author's abstract)
W90-08646

EFFECT OF TRIBUTYLTIN ON THE CHEMILUMINESCENT RESPONSE OF PHAGOCYTES FROM THREE SPECIES OF ESTUARINE FISH.
Virginia Inst. of Marine Science, Gloucester Point.
A. Wishkovsky, E. S. Mathews, and B. A. Weeks.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 6, p 826-831, November 1989. 6 fig, 27 ref.

Descriptors: *Antifoulants, *Estuarine fisheries, *Luminescence, *Organotin compounds, *Phagocytes, *Tin, *Tributyltin, *Water pollution effects, Bioassay, Biochemistry, Croaker, Ecotoxicology, Estuaries, Fish physiology, Hogchoker, In vitro tests, Sublethal effects, Tissue analysis, Toadfish.

The use of tributyltin (TBT) as an antifouling ingredient in marine paints has increased in the last decade. Tributyltin can leach from paint films and accumulate to hazardous levels, especially in the waters of harbors and marinas. Since certain toxic chemicals suppress cellular immune activity in fish, the present study was conducted to evaluate the effects of TBT on the chemiluminescent response of estuarine fish phagocytes. This effect was stud-

ied in vitro using kidney macrophages from oyster toadfish (Opsanus tau), hogchoker (Trinectes maculatus) and Atlantic croaker (Micropogonias undulatus). Phagocytic activity was evaluated using a luminol-amplified chemiluminescent assay with zymosan as the stimulus. Following brief exposure to selected doses of TBT, the chemiluminescent response of toadfish and hogchoker phagocytes was found to be significantly decreased at 400 micrograms/L TBT, while the croaker phagocytic activity was significantly decreased at 40 micrograms/L TBT. With 18 hour exposure to TBT, the effect on the chemiluminescent response was noticeable at lower doses (40 micrograms/L TBT for toadfish and 4 micrograms/L TBT for hogchoker). (Vernooy-PTT)
W90-08649

STUDY OF STEADY STATE AND KINETIC REGULATION OF CHLORIDE ION AND OSMOTIC PRESSURE IN HEMOLYMPH OF OYSTERS, CRASSOSTREA VIRGINICA, EXPOSED TO TRI-N-BUTYLTIN.
Yale Univ., New Haven, CT. Dept. of Biology.
E. Bokman, and R. B. Laughlin.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 6, p 832-838, November 1989. 5 fig, 1 tab, 17 ref.

Descriptors: *Animal physiology, *Antifoulants, *Chlorides, *Kinetics, *Organotin compounds, *Osmotic pressure, *Oysters, *Tin, *Tributyltin, *Water pollution effects, Bioassay, Biochemistry, Ecotoxicology, Hemolymph, Path of pollutants, Shellfish, Toxicity.

Two sets of experiments were made to determine if bis(tri-n-butyl)tin oxide (TBT; hexabutyl distannoxane) influenced osmotic pressure or chloride ion concentration in hemolymph of adult American oysters. In the first set, oysters were acclimated to 5, 25, or 40 ppt (parts per thousand) chloride ion, then exposed to bis(tri-n-butyl)tin oxide dissolved in seawater (0.5, 1.0 or 2.0 micrograms/L) for 11 days. Measurements of the total osmotic pressure and chloride ion concentration in hemolymph indicated that mean values of neither was significantly affected under steady state conditions. Oysters exposed to TBT exhibited a higher variation around the mean value for both total osmotic pressure and chloride ion concentration. There was significant mortality of oysters exposed to TBT in 25 and 40 ppt but not in 5 ppt chloride ion. In a second experiment, adult oysters were acclimated to 25 ppt and simultaneously exposed to the TBT concentrations listed above for 10 days. Then, subgroups of oysters were abruptly moved to 5 or 40 ppt and the time-course of adjustment of hemolymph osmotic pressure and chloride ion concentration was measured. During the first 24 hours, there was little adjustment to 5 ppt chloride ion in controls or TBT exposed oysters; apparently, they remained closed most or all of the time. In marked contrast, hemolymph of oysters moved to higher salinities rapidly readjusted. Exposure to TBT had a delaying effect on the schedule of the increase in hemolymph osmotic pressure and chloride ion concentration. Results of these experiments show that TBT has an indirect effect on osmotic pressure and chloride ion concentration adjustment in oysters; it does not appear to act strongly as an anionophore to influence anion transfer across epithelia. (Author's abstract)
W90-08650

EFFECTS OF ATRAZINE ON MICROCOSMS DEVELOPED FROM FOUR NATURAL PLANKTON COMMUNITIES.
Environmental Research Lab.-Duluth, MN.
F. S. Stay, A. Katko, C. M. Rohm, M. A. Fix, and D. P. Larsen.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 6, p 866-875, November 1989. 3 fig, 3 tab, 31 ref.

Descriptors: *Atrazine, *Bioassay, *Ecotoxicology, *Pesticide toxicity, *Plankton, *Toxicology, *Water pollution effects, Biological studies, Ecosystems, Herbicides, Plant populations, Primary productivity, Sensitivity analysis, Toxicity.

Comparisons were made among Leffler microcosms developed from four different natural communities and exposed to 0, 20, 100, 200, 500, 1000, and 5000 micrograms/L atrazine, a commonly used herbicide. Atrazine reduced net primary productivity, pH, and net productivity/respiration ratios in all four microcosm communities. In three of the four communities, the lowest observed (P < 0.05) effect concentration (LOEL) was 100 micrograms/L. In the fourth community the LOEL was 200 micrograms/L atrazine. The sensitivity and accuracy of bioassays with four different microcosm communities were evaluated by comparing results with values reported for acute and chronic single species bioassays, other types of microcosms, and experimental ponds exposed to similar concentrations of atrazine. The ranges of sensitivity noted in these experiments were less than the range reported for single species bioassays using common test organisms and similar to those reported for other microcosms. The similarity between Leffler microcosm results and the responses reported for the experimental ponds suggests that the Leffler microcosms accurately reflected concentrations causing ecosystem level changes in the experimental ponds. (Author's abstract)
W90-08652

ANALYSIS OF SIX FORAGING BEHAVIORS AS TOXICITY INDICATORS, USING JUVENILE SMALLMOUTH BASS EXPOSED TO LOW ENVIRONMENTAL PH.
State Univ. of New York at Syracuse. Coll. of Environmental Science and Forestry.
For primary bibliographic entry see Field 5A.
W90-08654

TOXICITY AND UPTAKE OF NITROGUANIDINE IN PLANTS.
Agricultural Research Service, Stoneville, MS.
Cotton Physiology and Genetics Unit.
For primary bibliographic entry see Field 5B.
W90-08657

PARASITISM IN MARINE FISH AFTER CHRONIC EXPOSURE TO PETROLEUM HYDROCARBONS IN THE LABORATORY AND TO THE EXXON VALDEZ OIL SPILL.
Memorial Univ. of Newfoundland, St. John's. Dept. of Biology.
R. A. Khan.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 5, p 759-763, May 1990. 1 tab, 18 ref.

Descriptors: *Alaska, *Chronic toxicity, *Gulf of Alaska, *Marine fisheries, *Oil spills, *Parasitism, *Water pollution effects, Animal pathology, Bioassay, Cod, Ecotoxicology, Exxon Valdez, Gills, Hydrocarbons, Oil pollution, Sculpin, Sublethal effects.

Since a previous study has shown that chronic exposure to crude oil fractions resulted in increased parasitism, this study was initiated to ascertain the relationship between trichodinid infections and exposure of fish to crude oil or its fractions. Studies were conducted in the laboratory and subsequently, in the Gulf of Alaska following the Exxon Valdez oil spill. Adult Atlantic cod (Gadus morhua) were exposed to crude oil in water (hydrocarbon concentration of 50 to 100 micrograms/L) for 12 weeks, followed by 2 weeks of depuration. Longhorn sculpins (Myoxocephalus octodecemspinosus) were exposed to oil-contaminated sediment (2200 micrograms/g) for 12 weeks with 20 weeks of subsequent depuration. In Alaska, samples of an intertidal sculpin, Oligocottus maculosus, were collected on August 20, 1989 (about 5 months after the spill), from uncontaminated areas and an oiled beach. Trichodinid infections on the gills of oil-treated longhorn sculpins and cod increased significantly when compared to the control groups: 88% of oiled cod were infected and had an average of 102.3 parasites/fish compared to 9% of controls with 0.9 parasites/host and parasites were about 17-fold greater among the oil treated sculpins than in controls. The infection was associated with hyperplasia of the lamellae with

parasites lying in the intervening troughs of the oiled cod. Examination of gill tissue from sculpins from Alaska showed that both the prevalence and intensity of Trichodina sp. were significantly greater in the oil-exposed group: 100% of exposed fish were infected and had an average of 14.3 parasites per fish versus 6% of nonexposed fish infected with an average of 0.2 parasites/fish. (VerNooy-PTT)
W90-08658

EFFECTS OF CUCL2 ON THE GERMINATION RESPONSE OF TWO POPULATIONS OF THE SALTMARSH CORDGRASS, SPARTINA ALTERNIFLORA.
Felician Coll., Lodi, NJ.
D. C. Waddell, and M. L. Kraus.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 5, p 764-769, May 1990. 3 fig, 7 ref.

Descriptors: *Copper, *Germination, *Salt marshes, *Spartina, *Toxicity, *Water pollution effects, Copper compounds, Ecotoxicology, Marsh plants, Plant growth, Seeds, Tidal marshes, Wetlands.

The saltmarsh cordgrass (Spartina alterniflora) is the dominant vascular plant in tidal marshes along the east and gulf coasts of the United States. It has been demonstrated that although copper (Cu) concentrations as high as 100 mg/L do not affect the germination response, seedlings grown in Cu solution exhibit 100% mortality within 56 days. This study was designed to examine population differences in the germination response of S. alterniflora to various concentrations of Cu. Seeds were collected from a polluted estuary (Sawmill Creek (SMC) near Lyndhurst, NJ) and a relatively nonpolluted creek (Big Sheepshead Creek (BSC) near Tuckerton, NJ). Average values of Cu in SMC soil, leaf and seed samples collected were 164.5 mg/kg, 45.3 mg/kg, and 37.1 mg/kg. BSC values were 42.6 mg/kg, 13.0 mg/kg, and 5.4 mg/kg. Germination rates in the BSC control group were significantly greater ($P < 0.05$) than in 50 mg Cu/L treatments, while no significant difference in germination rates existed between the BSC control and the 25, 100 or 150 mg/L treatment groups. All germinated seeds in both groups exhibited epicotyl growth, although radicles did not always emerge. Seeds from both populations germinated equally as well in the control treatments, but SMC seeds produced shorter epicotyls, and fewer radicles than did BSC seeds. Both populations of S. alterniflora produced equivalent seed weights. The heightened germination of BSC seeds, and the elongation of SMC epicotyls in the higher Cu concentrations, is probably due to physiological responses to Cu stress. It is possible that the lower concentration of Cu inhibited germination and growth, but higher Cu concentrations stimulated the seedlings, and caused them to over compensate due to the stress. (VerNooy-PTT)
W90-08659

ACUTE TOXICITY OF CADMIUM, COPPER, ZINC, AMMONIA, 3,3'-DICHLOROBENZIDINE, 2,6-DICHLORO-4-NITROANILINE, METHYLENE CHLORIDE, AND 2,4,6-TRICHLOROPHENOL TO JUVENILE GRASS SHRIMP AND KILLIFISH.
Johns Hopkins Univ., Silver Spring, MD. Applied Physics Lab.
D. T. Burton, and D. J. Fisher.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 5, p 776-783, May 1990. 1 tab, 20 ref.

Descriptors: *Ammonia, *Cadmium, *Chlorinated hydrocarbons, *Copper, *Ecotoxicology, *Killifish, *Shrimp, *Toxicity, *Toxicology, *Water pollution effects, *Zinc, Bioassay, Chemical wastes, Lethal limit, Median tolerance limit, Mortality, Phenols.

The acute toxicity of several compounds was investigated while performing a toxicity evaluation of a complex chemical effluent. Forty-eight hour static acute toxicity tests were run on juvenile grass shrimp (Palaemonetes pugio) and juvenile killifish or mummichogs (Fundulus heteroclitus) exposed to one of eight compounds. Two replicates of 10 organisms each were run at each test concentration, and a minimum of five concentrations was run using ASTM toxicity procedures except for the compounds 3,3'-dichlorobenzidine and 2.6-dichloro-4-nitroaniline. For these, the maximum concentration tested was at the solubility of the compound in the diluent water. The 48-hour LC50s for grass shrimp and killifish exposed to the various compounds were: cadmium (1.3 and 44.4 mg/L as Cd), copper (2.1 and 19.0 mg/L as Cu), zinc (11.3 and 96.5 mg/L as Zn), ammonia (1.2 and 1.6 mg/L), methylene chloride (108.5 and 97.0 mg/L), and 2,4,6-trichlorophenol (5.6 and 2.3 mg/L). Using 3,3'-dichlorobenzidine, grass shrimp experienced 10% mortality and killifish 50% mortality at 0.73 mg/L (the compound's solubility). For 2,6-dichloro-4-nitroaniline, the 48-hour LC50 for grass shrimp was 1.9 mg/L, while killifish experienced 20% mortality at 2.7 mg/L (the compound's solubility). (VerNooy-PTT)
W90-08660

ACCUMULATION OF METALS AND HISTOPATHOLOGY IN OREOCHROMIS NILOTICUS EXPOSED TO TREATED NNPC KADUNA (NIGERIA) PETROLEUM REFINERY EFFLUENT.
Ahmadu Bello Univ., Zaria (Nigeria). Dept. of Biological Sciences.
B. G. Onwumere, and A. A. Oladimeji.
Ecotoxicology and Environmental Safety EESADV, Vol. 19, No. 2, p 123-134, April 1990. 7 fig, 2 tab, 31 ref.

Descriptors: *Bioaccumulation, *Heavy metals, *Oil wastes, *Tilapia, *Toxicity, *Water pollution effects, Animal pathology, Cadmium, Chromium, Copper, Ecotoxicology, Fins, Gills, Histology, Industrial wastes, Iron, Lead, Liver, Manganese, Morbidity, Nickel, Nigeria, Tissue analysis, Zinc.

Accumulation of heavy metals and histopathology were observed in Oreochromis niloticus (formerly Tilapia L.) exposed to treated petroleum refinery effluents. Analysis of fish metal burden showed that the fish concentrated trace metals a thousand times above the levels existing in the exposure medium. Some metals were preferentially accumulated more than others and the accumulation was, in decreasing order, Pb, Fe, Zn, Cu, Mn, Cr, Ni, and Cd. Whole fish metal burden was lower in fish from which the gill, liver, and kidney had been removed, suggesting that these organs accumulated the metals more than other tissues. Hemorrhaging of fins was observed in all treatment concentrations except that of the control, and fish exposed to 40 and 50% effluent were most affected. Erosion of the caudal fin was also observed in fish exposed to 40 and 50% effluent. Examination of the organs for histopathology revealed damages to the gills. Gills with edematous fused lamellae congested with blood were observed. No histopathological damage was observed in the liver and kidney. The extent of metal accumulation and histopathological damage were directly related to effluent concentrations. (Author's abstract)
W90-08665

EVALUATION OF HEMATOTOXIC EFFECTS OF TWO COMMONLY USED FERTILIZERS, DIAMMONIUM PHOSPHATE AND UREA, ON FISH CLARIAS BATRACHUS.
Lucknow Univ. (India). Dept. of Zoology.
S. P. Trivedi, P. Singh, N. Sethi, and R. K. Singh.
Ecotoxicology and Environmental Safety EESADV, Vol. 19, No. 2, p 135-142, April 1990. 6 tab, 17 ref.

Descriptors: *Blood, *Diammonium phosphate, *Fertilizers, *Fish, *Phosphates, *Toxicity, Agricultural runoff, Ammonium compounds, Bioassay, Ecotoxicology, Fish physiology, Morbidity, Sublethal effects, Ureas, Water pollution effects.

Hematological parameters have been studied as indicators or monitors of prevailing aquatic pollution. In this study, the effects of two commonly used fertilizers, diammonium phosphate (nitrogen 18%, phosphoric acid 46%) (0 to 1.10 g/L) and urea (nitrogen 46.4%) (0 to 31.35 g/L), on hematological parameters (hemoglobin, red blood cell count, hematocrit, and total leucocyte count) of fresh water fish Clarias batrachus were studied. Groups of 10 fish were exposed for up to 144 hours. The toxic effect of diammonium phosphate was more pronounced than that of urea. Exposure to diammonium phosphate resulted in a sudden fall of hematological parameters, i.e., hemoglobin, red blood cell count, hematocrit, at higher concentrations and at lower concentrations gradual decreases were seen over comparatively longer durations. In urea intoxication, slight decreases in the three parameters were seen at lower concentrations during short intervals, while at higher concentrations, significant decreases during shorter intervals were observed. Total leucocyte count (TLC) increased during toxicity with both fertilizers, but higher elevations in TLC were produced by diammonium phosphate than by urea. (VerNooy-PTT)
W90-08666

GAS-BUBBLE DISEASE IN THREE FISH SPECIES INHABITING THE HEATED DISCHARGE OF A STEAM-ELECTRIC STATION USING HYPOLIMNETIC COOLING WATER.
Duke Power Co., Huntersville, NC. Applied Science Center.
M. C. McInerny.
Water, Air and Soil Pollution WAPLAC, Vol. 49, No. 1/2, p 7-15, January 1990. 1 fig, 2 tab, 21 ref.

Descriptors: *Bluegills, *Electric powerplants, *Fish diseases, *Fish physiology, *Largemouth bass, *Thermal pollution, *Water pollution effects, Cooling water, Discharge canals, Gas bubble disease, Gas saturation, Seasonal variation, Water temperature.

White bass (Morone chrysops), bluegill (Lepomis macrochirus), and largemouth bass (Micropterus salmoides) inhabiting the heated discharge canal of Duke Power Company's Marshall Steam Station, Lake Norman, North Carolina, were examined for signs of gas-bubble disease (GBD) during the winters of 1982-1983 and 1983-1984. Peak percentages of these fish species with GBD occurred between late February and early May each year, corresponding with peaks in total gas saturation in the discharge water. Cooling and warming water temperatures, and thermal stratification of Lake Norman influenced saturation of dissolved gases in the hypolimnetic intake water of Marshall Steam Station, and directly affected the variability in total gas saturation in the discharge canal. Temperature change in the condenser cooling water and electricity output were unrelated to the within-year variability in total gas saturation and GBD. The use of hypolimnetic water for cooling at this station restricts the time to a few months that levels of total gas saturation are sufficient to induce GBD, but probably led to higher peaks in GBD than if epilimnetic water was used. Among year, levels of GBD in white bass, bluegill, and largemouth bass were higher when electrical demand and mean temperature changes of the condenser cooling water at Marshall Steam Station were higher. Higher incidences in GBD in these fishes also occurred during winters when intake water temperatures were coldest. (Author's abstract)
W90-08686

ECOLOGICAL EFFECTS OF ATRAZINE ON TWO OUTDOOR ARTIFICIAL FRESHWATER ECOSYSTEMS.
Technische Univ. Muenchen (Germany, F.R.). Inst. fuer Botanik, Lehrgebiet Systematik und Oekophysiologie.
K. Neugebaur, F. J. Zieris, and W. Huber.
Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 23, No. 1, p 11-17, February 1990. 8 fig, 3 tab, 23 ref.

Descriptors: *Aquatic animals, *Aquatic organisms, *Aquatic plants, *Atrazine, *Herbicides, *Water pollution effects, Cladocerans, Macrophytes, Ostracods, Physicochemical properties, Phytoplankton.

Group 5C—Effects Of Pollution

The herbicide atrazine was applied in two artificial ponds at different times to determine if the results of the two experiments were comparable. Each pond was divided into three compartments. One of these compartments was used as an internal reference, the others were contaminated with two different concentrations of the herbicide. During the two test periods, physicochemical and biotic parameters were determined. The atrazine concentrations in the ponds were 20, 100 and 300 micrograms/L. These concentrations were maintained over eight weeks. The effects of the herbicide in the test systems were observed in the year of the application phase and in the following year. In the year of the application phase, the aquatic plants and the physicochemical parameters in the contaminated systems of both ponds were affected by atrazine. In the second year, the macrophytes recovered, but the phytoplankton and the aquatic fauna showed striking changes. The Cryptophyceae dominated the contaminated compartments, whereas the numbers of cladocerans and ostracods decreased. The smaller densities of the cladocerans and the ostracods in the contaminated compartments during the second year was not only a nutritive effect it was probably caused by the atrazine itself or its metabolites. Taking into consideration that both experiments took place at different times, the results are comparable. (Author's abstract)
W90-08693

CHANGE TO A DIATOM ASSEMBLAGE IN A EUTROPHIC LAKE FOLLOWING POINT SOURCE NUTRIENT RE-DIRECTION: A PALAEOLIMNOLOGICAL APPROACH.
University Coll., London (England). Palaeoecology Research Unit.
For primary bibliographic entry see Field 5G.
W90-08699

DIATOMS AS INDICATORS OF WATER QUALITY IN SOME ENGLISH URBAN LAKES.
Oxford Univ. (England). Geography School.
For primary bibliographic entry see Field 5A.
W90-08700

SEASONAL RESPONSE OF DIATOM COMMUNITIES TO VARIABLE WATER QUALITY IN SOME ENGLISH URBAN LAKES.
Oxford Univ. (England). Geography School.
For primary bibliographic entry see Field 5A.
W90-08701

STRUCTURAL, PHYSICAL AND CHEMICAL CHARACTERISTICS OF MICROCYSTIS AERUGINOSA HYPERSCUMS FROM A HYPERTROPHIC LAKE.
Kinneret Limnological Lab., Tiberias (Israel).
For primary bibliographic entry see Field 2H.
W90-08706

PHOSPHATASE ACTIVITY IN RELATION TO PHYTOPLANKTON COMPOSITION AND PH IN SWEDISH LAKES.
Uppsala Univ. (Sweden). Limnologiska Institutionen.
For primary bibliographic entry see Field 2H.
W90-08707

ENDLESS SUMMER: INTERNAL LOADING PROCESSES DOMINATE NUTRIENT CYCLING IN TROPICAL LAKES.
Michigan Univ., Ann Arbor. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-08708

ZOOPLANKTON-PHYTOPLANKTON INTERACTIONS IN A EUTROPHIC LAKE.
Department of Scientific and Industrial Research, Taupo (New Zealand). Taupo Research Lab.
For primary bibliographic entry see Field 2H.
W90-08710

QUANTITATIVE EXAMINATION OF MACROBENTHIC COMMUNITY CHANGES ALONG AN ORGANIC ENRICHMENT GRADIENT.
Washington Univ., Seattle. School of Oceanography.
For primary bibliographic entry see Field 2L.
W90-08717

MYTILUS EDULIS SHELL AS A BIOINDICATOR OF LEAD POLLUTION: CONSIDERATIONS ON BIOAVAILABILITY AND VARIABILITY.
Trent Univ., Peterborough (Ontario). Environmental and Resource Studies Program.
For primary bibliographic entry see Field 5A.
W90-08719

POLYCHAETE POPULATION DYNAMICS AND PRODUCTION IN THE NEW YORK BIGHT ASSOCIATED WITH VARIABLE LEVELS OF SEDIMENT CONTAMINATION.
National Marine Fisheries Service, Highlands, NJ. Sandy Hook Lab.
F. W. Steimle, P. Kinner, S. Howe, and W. Leathem.
Ophelia OPHLAN, Vol. 31, No. 2, p 105-123, March 1990. 10 fig, 4 tab, 46 ref.

Descriptors: *Benthic fauna, *New York Bight, *Polychaetes, *Sediment contamination, *Water pollution effects, Biomass, Growth, Hydrocarbons, Polychlorinated biphenyls, Production, Spatial distribution, Trace metals.

Methods for assessing effects of anthropogenic disturbances on marine benthic macrofauna are mostly based on community or population structure analysis. There are limited studies on functional effects, e.g., to growth or production. The population dynamics, growth curves, and production rates for nine common species of surface-deposit feeding or carnivorous polychaetes were examined at three locations in the contaminated New York Bight apex. These locations were environmentally similar, except for variable levels of sediment organic carbon and toxic chemicals (trace metal, PCBs, and polyaromatic hydrocarbons). One site was primarily affected by a nearby sewage sludge disposal site and had relatively moderate to high levels of overall chemical contaminants and low organic carbon in its sediments. At the second site levels of both organic carbon and other contaminants were relatively high the sediment. The third site represented a minimally contaminated site. The results suggest little difference in the relative growth patterns of these species, with variable production or production to biomass ratios (P:B) responses between the locations and their variable contamination levels. The range of P:B ratios was similar to those reported elsewhere for the same or related species in usually less contaminated areas. This suggests that the polychaetes were tolerant, to some degree, of elevated sediment contaminant levels found in the study area. (Author's abstract)
W90-08720

EFFECTS OF ATRAZINE IN ENVIRONMENTALLY RELEVANT CONCENTRATIONS ON SUBMERSED MACROPHYTES.
Ulm Univ. (Germany, F.R.). Abt. Allgemeine Zoologie (Biologie II).
A. Hofmann, and S. Winkler.
Archiv fuer Hydrobiologie AHYBA4, Vol. 118, No. 1, p 69-79, March 1990. 7 fig, 2 tab, 23 ref.

Descriptors: *Aquatic plants, *Atrazine, *Herbicides, *Macrophytes, *Pesticide toxicity, *Photosynthesis, *Plant growth, *Water pollution effects, Electron microscopy, Elodea, Light microscopy, Respiration.

Submerged macrophytes of Elodea canadensis, Fontinalis antipyretica, F. hypnoides, F. squamosa, Myriophyllum spicatum were contaminated with concentrations of atrazine, 2 and 10 micrograms/L, in 20 days and 24 hour intoxication assays. Effects of the herbicide were investigated by measurement of net photosynthesis and dark respiration, electron and light microscopical control of chloroplasts and plastoglobuli and residue analysis of the

active substance. Three different reaction types were found: (1) overshoot reaction in net photosynthesis followed by increased dark respiration; (2) tolerance against the stressor; (3) decrease of net photosynthesis leading to decay of the plants. Tolerance against a stressor may depend on the contamination at the plants' site of growth during the growth period. (Author's abstract)
W90-08724

FRESHWATER MUSSEL, WESTRALUNIO CARTERI IREDALE, AS A BIOLOGICAL MONITOR OF ORGANOCHLORINE PESTICIDES.
Western Australia Univ., Nedlands. Aquatic Research Lab.
For primary bibliographic entry see Field 5A.
W90-08725

SIMULATION OF INTERACTIONS BETWEEN MIGRATING WHALES AND POTENTIAL OIL SPILLS.
Applied Science Associates, Inc., Narragansett, RI.
For primary bibliographic entry see Field 5B.
W90-08730

POLLEN GERMINATION IS IMPEDED BY TAP WATER.
California Univ., Irvine. Dept. of Developmental and Cell Biology.
F. Hoffman, B. A. Martin, R. B. Sibley, and S. S. Tsay.
Environmental Pollution ENPOEK, Vol. 63, No. 2, p 179-187, 1990. 2 fig, 1 tab, 36 ref.

Descriptors: *California, *Contamination, *Drinking water, *Germination, *Plant growth, *Plant physiology, *Toxicity, Bioassay, Inhibition, Pollen, Tobacco.

Pollen germination in vitro is totally inhibited in tobacco (Nicotiana tabacum) and other species if tap water is used to prepare the germination medium. This effect is already fully present is tap water accounts for only 25% of the medium. Furthermore, the pollen grains deteriorate rapidly and the culture medium turns yellowish brown. The water toxicity is not caused by one or several compounds regularly monitored by the water authorities but can be removed by ion exchange purification. Although the factor(s) responsible for the inhibition were not identified, the study clearly shows the presence of such a contaminant in three different Orange County (Southern California) water wells. The fact that a fundamental botanical process like pollen germination is inhibited by a factor in drinking water not included in water quality control causes some general health concern. In addition, crop yield might be largely reduced if overhead spray irrigation with this water is utilized. The experiments also suggest that pollen germination in vitro could serve as a sensitive and simple bioassay for water quality. (Author's abstract)
W90-08733

HEALTH RISK ASSESSMENT OF TRICHLOROFLUOROMETHANE IN CALIFORNIA DRINKING WATER.
California Univ., Davis. Dept. of Environmental Toxicology.
N. R. Reed, W. Reed, K. Weir, L. M. Beltran, and R. Babapour.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-190391. Price codes: A05 in paper copy, A01 in microfiche. December 22, 1988. 82p, 4 fig, 10 tab, append. California Department of Health Services Interagency Master Agreement 85-87088.

Descriptors: *Drinking water, *Freon, *Path of pollutants, *Public health, *Risk assessment, *Trichlorofluoromethane, *Water pollution effects, Air pollution sources, Biological studies, California, Human physiology, Laboratory animals, Model studies, Population exposure, Toxicity.

Trichlorofluoromethane (Freon-11) is used as a blowing agent in the production of foams and as a refrigerant in industrial and commercial systems. In California, Freon-11 was detected in 3 or 2,949 wells in large water systems, at concentrations ranging from 0.2 to 3.9 microgm/L. A model that considers the ingestion, dermal, and inhalation routes of exposure associated with the use of Freon-11 contaminated drinking water is used in the estimation of human exposure. Approximately half of the total exposure is attributed to inhalation. An estimated population of 6,640 is receiving an average lifetime daily dose of 7.91 micromg/kg/day of Freon-11. Cardiac and pulmonary disturbances including cardiac arrhythmias, tachycardia, hypotension, and changes in respiratory rate, minute volume, tidal volume, and pulmonary compliance are the predominate toxic effects of Freon-11 in animals. Other effects include hepatic lesions, central nervous system dysfunction, and skin and eye irritation and inflammation. For rats, the acute oral no-observed-adverse-effect-levels was 7.38 mg/kg and the acute inhalation lowest-observed-adverse-effect-levels was 280 mg/kg. (Lantz-PTT)
W90-08759

AIR POLLUTION IN THE WIND RIVER MOUNTAIN WILDERNESS: A LONG-TERM MONITORING PROGRAM OF THE FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE.
Bridger-Teton National Forest, Jackson, WY.
A. F. Galbraith, and S. A. Stuart.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 121-126, 7 ref.

Descriptors: *Acid rain, *Environmental effects, *Headwaters hydrology, *Monitoring, *Water pollution sources, *Wind River Mountains, Acid neutralizing capacity, Air pollution, Alkalinity, Environmental impact, Forest watersheds.

For the past five years the Forest Service-USDA has conducted studies to determine the extent of and susceptibility to acid deposition and other air pollutants in the Bridger, Fitzpatrick and Popo Agie Wildernesses, located in the Wind River Mountains, Wyoming. These wildernesses contain approximately 2000 alpine and subalpine lakes which support some of the finest trout fisheries found in the continental United States. Due to the granitic nature of the lake watersheds, the natural acid neutralizing capacity is severely limited. Furthermore, these wildernesses lie downwind of significant industrial and metropolitan sources of air pollution. The overall monitoring effort has included studies of selected stream and lake chemistry, precipitation chemistry, macroinvertebrate and zooplankton indicators, specific lichen and moss biomonitors, lakebed sediment analysis, soil physical and chemical properties, and air quality measurements. The Wind River Mountains have experienced air pollution in the past sufficient to produce heavy metal deposition and precipitation acidity close to if not exceeding an acidification threshold. The most sensitive setting in the Wildernesses is the alpine zone which may receive the highest amount of acid and trace metal deposition. Although too early to confirm a trend, the acidity of the precipitation falling in the Wind River Mountains decreased from 1983 to 1985. Unlike areas of southern Scandinavia, central Europe, eastern Canada, and the northeastern United States, where air pollution affects upon surface water acidity and vegetation response are advanced, the sensitive components of the wilderness ecosystem in the Wind River Mountains are at this time at an incipient stage of stress. (See also W90-08822) (Lantz-PTT)
W90-08835

CLASSIFICATION AND SPATIAL MAPPING OF RIPARIAN HABITAT WITH APPLICATIONS TO MODELING INSTREAM IMPACTS OF AGRICULTURAL NONPOINT SOURCE POLLUTION.
Idaho Univ., Moscow. Dept. of Plant, Soil and Entomological Sciences.
M. D. Delong, R. Rhew, and M. A. Brusven.
IN: Proceedings of the Symposium on Headwaters

Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 269-275, 1 tab, 10 ref.

Descriptors: *Agricultural runoff, *Classification, *Headwaters hydrology, *Model studies, *Nonpoint pollution sources, *Riparian vegetation, *Water pollution effects, *Watershed management, Idaho, Maps, Tom Beall Creek.

Management of riparian habitats has been recognized for its importance in reducing instream effects of agricultural nonpoint source pollution. By serving as a buffer, well structured riparian habitats can reduce nonpoint source impacts by filtering surface runoff from field to stream. A system has been developed where key characteristics of riparian habitat, type, height, width, and bank slope, are classified as discrete categorical units. This classification system recognizes seven riparian types: no riparian, annual herbaceous crop, perennial herbaceous crop, wild herbaceous, herbaceous/shrub mixture, shrubs, and trees. Bank slope and riparian width and height each consist of five categories. Classification by discrete units allows for ready digitizing of information into a geographic information system (GIS). From GIS, the integration of digitized maps of riparian habitat with land use, slope, soil types, and soil erodibility maps can aid in determining areas along a stream that are most susceptible to nonpoint source inputs. Such an integrated system is discussed for Tom Beall Creek watershed, an agriculturally impacted third order stream in the Clearwater River drainage, Nez Perce County, Idaho. (See also W90-08822) (Author's abstract)
W90-08850

CONTROL OF ATTACHED ALGAE BY NITROGEN AND PHOSPHORUS IN THE CLARK FORK RIVER.
Montana Univ., Missoula.
V. Watson.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 287-297, 4 fig, 14 ref.

Descriptors: *Algal growth, *Clark Fork River, *Eutrophication, *Headwaters hydrology, *Montana, *Nitrogen, *Phosphorus, *Water pollution control, *Water pollution effects, Algae, Nutrients, Periphyton, Wastewater pollution.

Growing concern over possible nuisance algae accumulations in the Clark Fork River of Western Montana has prompted studies of the role of dissolved N and P in controlling attached algae in the river. Dissolved N and P levels in the river were compared to levels that experimental studies suggest limit algal growth or standing crop. Ratios of N and P in the water were also evaluated to determine which nutrient (if either) has the dominant role in limiting attached algae. Assuming that dissolved P levels below 40 ppb and N levels below 50 ppb can limit periphyton standing crop, dissolved N and P levels are low enough to be limiting to periphyton standing crop in much of the river over much of the year. Whether or not changes in nutrients actually would produce a proportionate change in algal levels depends on many site specific factors that cannot be easily tested in artificial streams (such as, instream grazing rates, scour by ice and high flows, and seasonally changing water, flow and light level). The relative importance of N and P limitation varied in time and space over the river. Near the river's headwaters, P limitation (N:P ratio > 20) was more common. Below the town of Deer Lodge, down to the confluence with the Blackfoot, N limitation (N:P ratio < 5) was more common (especially in the summer). From the confluence with the Blackfoot River to the Missoula sewage plant, limitation was approximately evenly balanced. The site below the sewage plant (where both nutrients were often in excess of the above described levels), N was limiting more often. From the confluence with the Bitterroot River to that with the Flathead, sites showed N limitation more often or exhibited an approximate balance between N and P. Below the confluence with the Flathead, P limitation was most common. The heaviest algal

standing crops occur in those reaches with low N:P ratios. The high P levels at these sites probably permit algae to deplete N levels in the water. N fixation is likely to be important in supporting these heavy algae accumulations. The greatest control in algae standing crops is most likely to be achieved by controlling both N and P loads to the river. It is likely that a greater reduction can be achieved in P levels since a greater percent of P loads are likely to be associated with point sources than is true of N. (See also W90-08822) (Lantz-PTT)
W90-08852

DEFINING ACIDIFICATION STATUS OF UNGLACIATED HEADWATER APPALACHIAN CATCHMENTS.
Pennsylvania State Univ., University Park. School of Forest Resources.
For primary bibliographic entry see Field 5B.
W90-08874

ROLE OF ATMOSPHERIC DEPOSITION IN STREAMFLOW GENERATION AND EPISODIC WATER QUALITY.
Vermont Univ., Burlington.
For primary bibliographic entry see Field 5B.
W90-08875

EFFECT OF MINING ON WATER QUALITY.
Arizona Dept. of Environmental Quality, Phoenix.
For primary bibliographic entry see Field 4C.
W90-08886

IMPACT OF ACID MINE DRAINAGE ON BENTHIC MACROINVERTEBRATES (PLECOPTERA) IN A MONTANE STREAM.
Montana Univ., Missoula.
J. T. Gangemi.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 645-653, 7 fig, 3 tab, 19 ref, append.

Descriptors: *Acid mine drainage, *Benthic fauna, *Ecotoxicology, *Headwaters hydrology, *Macroinvertebrates, *Mountain streams, *Water pollution effects, Blackfoot River, Chemical precipitation, Ferrous hydroxide, Heavy metals, Hydrogen ion concentration, Mine wastes, Mortality, Water pollution sources.

The discharge of acid mine drainage continues to persist in a montane stream despite closure of the mine 24 years ago. Benthic macroinvertebrates are unable to establish residence in these waters characterized by high dissolved metals and precipitation of ferric hydroxide. Water and benthic macroinvertebrate samples were taken at four stations on the headwaters of the Blackfoot River in an attempt to correlate physical parameters with biotic distribution; two control sites were compared to two sites impacted by acid mine drainage. Physical measurements included pH, dissolved oxygen, conductivity, alkalinity, dissolved and total recoverable metals. Benthic macroinvertebrates were identified to genus in orders where taxonomic keys permitted. Benthic macroinvertebrate mortality is 100% at a distance of 2 km below the point source of unchecked acid mine drainage. A combination of factors are ultimately the cause for this response; acute heavy metal concentrations acting alone and synergistically, unsuitable substrate habitat, and lcak of food quality and quantity. No single factor leading to the absence of aquatic insects can be isolated in this study. The magnitude of this impact on sites further downstream is, as of this date, not confirmed but assumed to suppress density and diversity indexes below those typical of a montane stream. Several of the factors contributing to mortality could be reduced through diversion of the acid mine waters to an already existing containment pond less than 1/2 km from the point source. (See also W90-08822) (Lantz-PTT)
W90-08887

Group 5C—Effects Of Pollution

PACLOBUTRAZOL AND ROOT ZONE WATER CONTENT INFLUENCE PEACH SEEDLING BEHAVIOR.
Bologna Univ. (Italy). Ist. di Coltivazioni Arboree.
R. Biasi, G. Costa, F. Succi, C. Nishijima, and G. C. Martin.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 114, No. 6, p 923-926, November 1989. 2 fig, 2 tab, 26 ref.

Descriptors: *Paclobutrazol, *Peaches, *Plant growth, *Plant water potential, *Stomatal transpiration, Herbicides, Plant physiology, Temporal variation.

Potted peach (Prunus persica (L.) Batsch.) seedlings were grown in the greenhouse at three water levels (25%, 50% and 100% field capacity (FC)) with experiments duplicated in Bologna, Italy and Davis, California. One group of the seedlings was treated with 0.1 g active ingredient paclobutrazol (PBZ), a vegetation growth inhibitor, applied as a soil drench, whereas the second group received water only. Addition of PBZ suppressed shoot growth and leaf area more than reduced water content alone. PBZ reduced root fresh and dry weights and total water consumption. at 0600 and 1200 hours, PBZ increased stomatal conductance at 100% FC; later that same day stomatal conductance decreased. At 50% and 25% FC, PBZ decreased stomatal conductance compared with controls at all times measured. (Author's abstract)
W90-08906

WATER CONTAMINATION AND ESOPHAGEAL CANCER AT GASSIM REGION, SAUDI ARABIA.
King Faisal Specialist Hospital and Research Centre, Riyadh (Saudi Arabia). Dept. of Oncology and Biological and Medical Research.
For primary bibliographic entry see Field 5F.
W90-08939

ACIDIFICATION AND RECOVERY OF SPODOSOL BS HORIZON FROM ACIDIC DEPOSITION.
Syracuse Univ., NY. Dept. of Civil and Environmental Engineering.
R. A. Dahlgren, D. C. McAvoy, and C. T. Driscoll.
Environmental Science and Technology ESTHAG, Vol. 24, No. 4, p 531-537, April 1990. 8 fig, 3 tab, 35 ref.

Descriptors: *Acid rain effects, *Acidic soils, *Acidification, *Maine, *Soil contamination, Aluminum, Bear Brook Watershed, Chemical reactions, Experimental basins, Leaching, Self-purification.

A laboratory study was conducted to examine acidification and recovery of Spodosol Bs horizon and acidic deposition in the Bear Brook Watershed, central Maine. A mechanical vacuum extractor was used to draw solutions through a soil column at three treatments containing 40, 100, or 160 micromole/L sulfate. Following 44 days of leaching, all treatments were decreased to the 40 micromole/L sulfate level to examine recovery from acidification. Acid additions initially were neutralized by release of basic cations and sulfate adsorption. Following attainment of steady-state conditions for basic cations and sulfate with respect to the soil adsorption complex, Al dissolution was the primary neutralization mechanism. Aqueous Al activities appeared to be regulated by equilibrium with an Al(OH)3 mineral phase. Following decreases in acid loadings, recovery was rapid, resulting in retention of basic cations, reversible release of sulfate, and a marked reduction in the concentration of soluble Al. (Author's abstract)
W90-08945

REGIONAL NATURE OF LAKE WATER QUALITY ACROSS MINNESOTA: AN ANALYSIS FOR IMPROVING RESOURCE MANAGEMENT.
Minnesota Pollution Control Agency, Roseville. Div. of Water Quality.
For primary bibliographic entry see Field 2H.

W90-08980

WATER QUALITY AND MANAGEMENT OF LAKES IN THE TWIN CITIES METROPOLITAN AREA.
Metropolitan Council, St. Paul, MN.
For primary bibliographic entry see Field 5G.
W90-08981

HEXAGENIA MAYFLIES: BIOLOGICAL MONITORS OF WATER QUALITY IN THE UPPER MISSISSIPPI RIVER.
Winona State Univ., MN. Dept. of Biology.
For primary bibliographic entry see Field 5A.
W90-08991

MANAGEMENT OF THE RIVER RHINE.
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
For primary bibliographic entry see Field 5G.
W90-09000

BIOGEOCHEMISTRY OF IRON IN AN ACIDIC LAKE.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 2H.
W90-09051

GROUND WATER CONTAMINATION: SOURCES, EFFECTS AND OPTIONS TO DEAL WITH THE PROBLEM.
For primary bibliographic entry see Field 5B.
W90-09063

UNCERTAINTIES IN PREDICTIVE TOXICOLOGY AND RISK ASSESSMENT.
E. J. Calabrese, and C. E. Gilbert.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 21-46, 68 ref.

Descriptors: *Epidemiology, *Groundwater pollution, *Groundwater quality, *Public health, *Toxicology, *Water pollution effects, Carcinogens, Drinking water, Model studies, Population exposure, Risk assessment.

Two of the greatest limitations of epidemiological investigations are the precise estimation of human exposure to the chemical carcinogens in question and the influence of potentially confounding variables, particularly in studies of an ecological nature. As a result of the need to determine personal chemical exposure before any risk can be estimated and the general deficiencies of most earlier studies in the area of organic carcinogens in drinking water, there has been a strong orientation for ecological studies to be followed by investigations in which considerable data are collected on the level of the individual. A major development in the area of epidemiology is to utilize the biomedical/toxicological sciences so that quantification of exposure can be more accurately determined. Animal extrapolation issues include mouse hepatoma and extrapolative relevance, peroxisome proliferation, and differences in enterohepatic circulation. The use of safety factors for determining acceptable levels of carcinogens in drinking water is not presently employed; however, a major issue is whether some carcinogens may act by a threshold response. Hormesis is a term used to describe the positive stimulation by subharmful quantities of any agent to any biological system. Hormetic associations have been studied extensively with respect to both radiation and chemical agents, including a wide range of inorganics (ie., Pb, Cd, Cu) and organics (ie., PAH, pesticides). Evidence exists that hormetic dose-response relationships for radiation may also be valid. In drinking water, multiple contaminants are common, yet such agents are usually studied separately in animals. The number of possible combinations of exposures is multiplicative and far exceeds the capacity of the toxicological community to assess even a very small percentage of the permutations. A better understanding is needed of cellular mechanisms and chemical disposition of individual agents before biologically/chemically realistic models for predictions can be developed and tested. (See also W90-09063)(Fish-PTT)
W90-09064

BASIS FOR ACTION.
For primary bibliographic entry see Field 5G.
W90-09065

RISK ASSESSMENT AS A BASIS FOR ACTION.
For primary bibliographic entry see Field 5G.
W90-09066

HOW SHOULD GROUND WATER HEALTH STANDARDS BE SET. POSSIBLE APPROACHES TO STANDARDS SETTING.
For primary bibliographic entry see Field 5G.
W90-09067

EFFECTS OF WATER-SOLUBLE FRACTION OF THE MEXICAN CRUDE OIL 'ISTHMUS CACTUS' ON GROWTH, CELLULAR CONTENT OF CHLOROPHYLL A, AND LIPID COMPOSITION OF PLANKTONIC MICROALGAE.
Centre d'Oceanologie de Marseille (France).
M. R. Morales-Loo, and M. Goutz.
Marine Biology MBIOAJ, Vol. 104, No. 3, p 503-509, March 1990. 4 fig, 2 tab, 39 ref.

Descriptors: *Algae, *Oil pollution, *Phytoplankton, *Phytotoxicity, *Water pollution effects, Chlorophyll, Chlorophyta, Cryptophyta, Cyanophyta, Diatoms, Dinophyta, Growth rates, Lipids, Marine algae, Phospholipids, Photosynthesis, Sterols, Toxicity.

Phytoplankton species were grown in batch cultures in the presence of the water-soluble fraction (WSF) of a Mexican crude oil (Isthmus Cactus) at concentrations of 50 and 100%. Both growth retardation and growth stimulation were seen in the algal cultures. Four algae, the bacillariophytes (diatoms) Nitzschia closterium and Asterionella glacialis, the cryptophytes Rhodomonas lens, and the chlorophyte Dunaliella tertiolecta, showed retarded growth. Growth retardation (indicated by minus sign) and growth stimulation (indicated by plus sign) for the algae exposed to 50% and 100% WSF, respectively, were as follows: Nitzschia, - 24.3% and -59.6%; Asterionella, -27.7% and - 54.5%; Rhodomonas, -4.0% and -16.4%; Dunaliella, -4.1% and -4.5%; Agmenellum, +3.4% and +5.6%; Skeletonema, +2.4% and -6.1%; and Prorocentrum, +6.2% and +11.2%. In most of these algae cellular chlorophyll a, lipid pigments, glycolipids and triglycerides decreased while sterols and hydrocarbons accumulated. No change was seen in phospholipids during the experiments. The cyanophyte Agmenellum quadruplicatum and the bacillariophyte Skeletonema costatum were less sensitive to the WSF. The cell yield of the dinophyte Prorocentrum minimum was stimulated by the WSF. In the three latter species (Agmenellum, Skeletonema, and Prorocentrum) lipid pigments were enhanced or remained at control levels. It was concluded that the toxic effect of the WSF was caused by disruption of the biosynthesis mechanisms required for photosynthesis. (Cassar-PTT)
W90-09199

IMPACT OF INTERNAL PHOSPHORUS LOADING ON THE RESTORATION OF TROUT LAKE.
North Dakota Univ., Grand Forks. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5G.
W90-09209

ECOTOXICOLOGY AND ECOSYSTEM INTEGRITY: THE GREAT LAKES EXAMINED.
Wisconsin Univ.-Green Bay.
For primary bibliographic entry see Field 2H.
W90-09213

TOXIC SUBSTANCES IN SURFACE WATER.
George Washington Univ., Washington, DC. Div. of Occupational and Environmental Medicine.
For primary bibliographic entry see Field 5G.
W90-09214

OIL SPILLAGE IN ANTARCTICA: INITIAL REPORT OF THE NATIONAL SCIENCE FOUNDATION-SPONSORED QUICK RESPONSE TEAM ON THE GROUNDING OF THE BAHIA PARAISO.
Texas A and M Univ., College Station.
M. C. Kennicutt.
Environmental Science and Technology ESTHAG, Vol. 24, No. 5, p 620-624, May 1990. 2 fig, 2 tab.

Descriptors: *Antarctica, *Environmental impact, *Fate of pollutants, *Marine environment, *Oil spills, *Water pollution effects, Bahia Paraiso, Hydrocarbon analysis, Intertidal areas.

On January 28, 1989, the Argentine ship Bahia Paraiso ran aground near Anvers Island on the Antarctic Peninsula. More than 150,000 gallons of petroleum, primarily diesel fuel arctic (DFA) were released to the surrounding bays. The immediate effects of the spill were restricted to within a few kilometers of the wreck over a several-week period due to reduction in leakage, cleanup, weathering of the spill, and flushing of the area. The intertidal zone was most directly affected with oil-fouled macroalgae, limpets, birds, sediments, and rocks. Little sediment is present in the study area, and most beaches are composed of pebble-sized or larger rocks, which provide few places for the slick to concentrate away from wave and wind action. This setting prevents the oil from permanently depositing on the islands, except on beaches and above the surf zone, and ultimately results in evaporation, transport from the area, and dilution of the slick. Several factors contributed to limiting the impact of the spill both areally and over time. These factors include the volatility of the released product, the volume of material released, the variable and severe weather conditions, the common occurrence of off-shore winds and currents, and the lack of low-energy intertidal areas for the fuel to accumulate. The primary removal mechanisms were evaporation, dilution, and transport from the area, with only minor affects from microbial oxidation, photooxidation, and biological uptake. Longer term sublethal effects have yet to be documented but appear to be limited to limpet and bird population dynamics if any can be recognized at all. (Chonka-PTT)
W90-09216

LAKE DYNAMICS AND THE EFFECTS OF FLOODING ON TOTAL PHOSPHORUS.
National Hydrology Research Inst., Saskatoon (Saskatchewan).
For primary bibliographic entry see Field 2H.
W90-09233

FILTERING RATES OF DIAPTOMUS MINUTUS, BOSMINA SPP., DIAPHANOSOMA SP., HOLOPEDIUM GIBBERUM (CRUSTACEA), AND ZOOPLANKTON COMMUNITY GRAZING RATES IN SOME ACIDIC AND CIRCUMNEUTRAL ONTARIO LAKES.
Toronto Univ. (Ontario). Inst. for Environmental Studies.
For primary bibliographic entry see Field 2H.
W90-09235

EVALUATION OF THE EFFECTS OF ATMOSPHERIC ACIDIC DEPOSITION ON FISH AND THE FISHERY RESOURCE OF CANADA.
Department of Fisheries and Oceans, Sault Ste. Marie (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences.

J. R. M. Kelso, M. A. Shaw, C. K. Minns, and K. H. Mills.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 3, p 644-655, 1990. 2 fig, 7 tab, 111 ref.

Descriptors: *Acid lakes, *Acid rain effects, *Acidic water, *Canada, *Fish populations, Biomass, Ecological effects, Lake acidification, Lake fisheries, Lake restoration, Water pollution effects.

In Canada, 7.6% of the nation's surface area is water, and approximately 38% of this is found in regions susceptible to acidic atmospheric deposition. It was estimated that 390,000 lakes in eastern Canada are sensitive to acidification, and provide significant revenue through the sport fishery to the economy. Evidence indicates that Sudbury lakes and Nova Scotian rivers acidified in the 1950's, 1960's, and probably early 1970's. Well documented cases of loss of fish species or production due to acidification are restricted to these two regions. However, the documentation of low pH lakes in areas of high acid loading suggest that acidification is more widespread. Recent increases in pH in some Sudbury and Algoma lakes, concomitant with reestablishment of fish populations, indicates that chemical and biological recovery is possible. Evidence from diverse experimental approaches--surveys, bioassays, and whole lake manipulation--are supportive in identifying fish responses to acidification. Fish community response is dependent upon several factors: complexity of the community, stage of acidification, species sensitivity, and availability of tolerant species to invade. If replacement of extirpated species by tolerant ones occurs, total fish biomass may remain stable until critical depauperation. It is unlikely that direct documentation of further losses due to acidification will be possible. (Author's abstract)
W90-09239

EFFECT OF VARYING WATER PH ON THE ACIDIFICATION OF EXPIRED WATER IN RAINBOW TROUT.
British Columbia Univ., Vancouver. Dept. of Zoology.
H. Lin, and D. J. Randall.
Journal of Experimental Biology-NAL JEBIAM, Vol. 149, p 149-160, March 1990. 7 fig, 2 tab, 9 ref.

Descriptors: *Acid rain effects, *Ammonia, *Carbon dioxide, *Fish physiology, *Hydrogen ion concentration, *Trout, Acidic water, Alkalinity, Gills, Sodium.

Fish excrete molecular CO_2 and NH_3 into the water passing over the gills. The excretion rates are an order of magnitude greater for CO_2 than for NH_3. Some carbon dioxide is excreted as bicarbonate in exchange for chloride, and some ammonia as ammonium ion in exchange for sodium. Rainbow trout (Salmo gairdneri, Richardson), weighing 324-494 g. were obtained from a trout farm in Aldergrove, British Columbia, Canada. Acidification of expired water was studied in the rainbow trout exposed to water of pH 9.91, 6.8 (control), and 3.88. For the high-pH and the control exposures, the water flowing over the gills was acidified because of the dominant effect of CO_2 hydration. During the low-pH treatment, the water was alkalized because of ammonium ion formation and perhaps bicarbonate dehydration. Carbon dioxide excretion was not significantly affected by the high-pH and low-pH treatments but ammonia accumulated in the plasma in both cases. The overall result of CO_2 and NH_3 excretion is to ameliorate the magnitude of the change in water pH next to the gills in the face of changes in pH of the environmental water. Inspired water pH varied from 3.88 to 9.91 but expired pH varied from 4.33 to 7.10. Thus, the high permeability of the gill epithelium to non-ionic but not ionic forms of carbon dioxide and ammonia maintains a relatively stable pH in the micro-environment of the fragile gill epithelium of fish. (Mertz-PTT)
W90-09241

RESPONSE OF ANABAENA DOLIOLUM TO BIMETALLIC COMBINATIONS OF CU, NI AND FE WITH SPECIAL REFERENCE TO SEQUENTIAL ADDITION.

Banaras Hindu Univ., Varanasi (India). Centre for Advanced Study in Botany.
N. Mallick, and L. C. Rai.
Journal of Applied Phycology JAPPEL, Vol. 1, No. 4, p 301-306, December 1989. 2 fig, 2 tab, 21 ref.

Descriptors: *Anabaena, *Analytical methods, *Bacterial physiology, *Cyanophyta, *Heavy metals, *Water analysis, *Water pollution effects, Analysis of variance, Antagonistic effects, Bioassay, Biochemical tests, Copper, Enzymes, Inhibition, Iron, Nickel, Synergistic effects, Toxicity.

The physiological features of a N(2)-fixing cyanobacterium Anabaena doliolum vary in response to metal mixtures. Exposure of the cyanobacterium to Cu, Ni and Fe individually, as well as in combinations (Cu+Ni, Cu+Fe, Ni+Fe), resulted in marked differences in growth inhibition, nutrient uptake (ammonium and nitrate), photosynthesis, ATP content, nitrate reductase, glutamine synthetase, and urease activities. The response to metal combinations was also dependent upon the order in which the metals were added. The Cu-Ni combination resulted in synergistic interaction, in contrast to the antagonism of Cu-Fe and Ni-Fe. Pre-addition of Fe protected the cyanobacterium against Cu and Ni toxicity. Statistically significant inhibition of all the processes following metal supplementation was observed. This study suggests that carbon fixation is the most suitable variable for assessing heavy metal toxicity. (Author's abstract)
W90-09276

HISTOPATHOLOGICAL LESIONS IN THE BODY ORGANS OF CAT-FISH (HETEROPNEUSTES FOSSILIS) FOLLOWING MERCURY INTOXICATION.
Jawaharlal Nehru Medical Coll., Aligarh (India). Interdisciplinary Brain Research Centre.
Y. Bano, and M. Hasan.
Journal of Environmental Science and Health (B) JPFCD2, Vol. 25, No. 1, p 67-85, February 1990. 10 fig, 38 ref.

Descriptors: *Animal pathology, *Catfish, *Histology, *Mercury, *Toxicity, *Water pollution effects, Animal morphology, Intestine, Kidneys, Liver, Microscopic analysis, Ovary, Spleen.

Light microscopic study of different body organs of catfish following exposure to 0.2 mg/L HgCl(2) in water for 30 days revealed that focal degeneration of liver cells and disorganization of hepatic cords occurred. Centrilobular atrophy and compensary hypertrophy of some hepatic cells were also observed. In the kidneys, degeneration of renal epithelium along with displacement of nuclei, shrinkage of glomeruli, breakdown of Bowman's capsule, and heavy infiltration by inflammatory cells were observed. The histopathological changes noted in the intestine included degeneration of lining epithelium and diminution of goblet cells. Microscopic sections of ovaries exhibited reduction of ooplasm, leading to the formation of atypical oocytes. An increase in the occurrence of atretic oocytes and interfollicular spaces was also discernable. No histopathological lesions could be detected in testes of male fish, probably because of the difference in the maturity of the control and experimental groups. The pathomorphological alterations in relation to mercury toxicity in the spleen were associated with the disorganization of the splenic cords and resulted in the displacement of lymphatic tissue cells within the substance of splenic pulp. Marked depletion of the red pulp was noticeable. (Author's abstract)
W90-09280

IN VIVO EFFECT OF MONOCROTOPHOS ON THE CARBOHYDRATE METABOLISM OF THE FRESHWATER SNAKE HEAD FISH, CHANNA PUNCTATUS.
Maharshi Dayanand Univ., Rohtak (India). Dept. of Biosciences.
M. Samuel, and K. V. Sastry.
Pesticide Biochemistry and Physiology PCBPBS, Vol. 34, No. 1, p 1-8, May 1989. 4 tab, 30 ref.

Descriptors: *Carbohydrate metabolism, *Fish physiology, *Organophosphorus pesticides, *Pesticides, *Water pollution effects, Biochemical tests, Blood, Enzymes, Lethal limit, Liver, Monocrotophos, Muscle, Sublethal effects, Tissue analysis.

The effects of exposure to the organophosphate pesticide monocrotophos on the levels of some biochemical and enzymological parameters in blood, liver, and muscle of Channa punctatus were studied. Healthy fish were exposed to the LC50 (10 ppm) for 96 hr or to a sublethal concentration (1 ppm) of the pesticide for 15, 30, 60, or 120 days. Fish exposed for 96 hr and 15 days were hypoglycemic and hypolactemic. A decrease was noted in the pyruvic acid level in blood and in the activity of liver hexokinase. In muscle, a decrease in the glycogen content and an increase in the lactic acid level indicated hyperactivity. After 30 days of exposure, hyperglycemia, hyperlactemia, a decrease in liver glycogen, an increase in the muscle glycogen and in the activity of hexokinase, and a decrease in the activities of malate dehydrogenase (MDH) and succinate dehydrogenase (SDH) indicated that anaerobic metabolism prevailed over aerobic metabolism. After 60 and 120 days of exposure, both aerobic and anaerobic pathways were impaired as evidenced by the hypoglycemia, the hypolactemia, the decrease in pyruvic acid level of blood, the increase in the glycogen content of both liver and muscle, and the decrease in the activities of glucose-6-phosphatase, hexokinase, SDH, and MDH. The activities of glutamate-oxalacetate transaminase and glutamate-pyruvate transaminase increased in the liver, muscle, and blood in acute exposure and in all the stages of chronic exposure. (Author's abstract)
W90-09282

MULTIPLE EFFECTS OF ACID AND ALUMINUM ON BROOD STOCK AND PROGENY OF FATHEAD MINNOWS, WITH EMPHASIS ON HISTOPATHOLOGY.
Minnesota Univ.-Duluth. Dept. of Anatomy and Cell Biology.
R. L. Leino, J. H. McCormick, and K. M. Jensen.
Canadian Journal of Zoology CJZOAG, Vol. 68, No. 2, p 234-244, February 1990. 24 fig, 6 tab, 26 ref.

Descriptors: *Acid rain effects, *Acidic water, *Aluminum, *Fathead minnows, *Fish diseases, *Hydrogen ion concentration, *Water pollution effects, Acidification, Eggs, Gills, Hatching, Laboratory methods, Spawning.

Thirty-day-old fathead minnows, Pimephales promelas, were reared at different pH values in softened Lake Superior water enriched with aluminum: pH 7.5-35 microgram Al/L; pH 5.5-30 microgram Al/L, pH 5.2-35 and 60 microgram Al/L, including a background level of 15 microgram Al/L; and at pH 7.5, 6.0, 5.5, and 5.2 at background Al levels. Spawning was greatly reduced at pH 6.0, pH 5.5-30 microgram Al/L, and pH 5.5 and failed at pH 5.2 with or without added Al. The adult brood stock exhibited abnormalities at low pH, which could have contributed to poor spawning success or energy utilization. Abnormalities included: thickened respiratory epithelium in the gills; hyperplasia of primary lamellar epithelium in the gills; increased number of gill chloride cells; reduced gill perfusion; immature ovaries and oocyte atresia; immature and pathologic testes; abnormal distal tubules and collecting ducts in the kidneys; and reduced blood osmality at pH 5.5 and 5.2 when no Al was added. Hatching success and larval survival were reduced when spawning occurred at or below pH 6.0; these larvae often had retarded swim bladder development and yolk absorption and some stages had abnormal gills, kidneys, and liver glycogen reserves. The study further supports the relationship between acidification, histological changes, ionoregulatory disturbances, altered energy metabolism, and recruitment failure. (Author's abstract)
W90-09289

IMPACT OF DELTAMETHRIN INSECTICIDE ON CHIRONOMIDEA (DIPTERA) OF PRAIRIE PONDS.
Saskatchewan Univ., Saskatoon. Dept. of Biology.
P. K. Morrill, and B. R. Neal.
Canadian Journal of Zoology CJZOAG, Vol. 68, No. 2, p 289-296, February 1990. 5 fig, 3 tab, 43 ref.

Descriptors: *Agricultural chemicals, *Insecticides, *Midges, *Ponds, *Prairies, *Water pollution effects, Deltamethrin, Environmental effects, Population density.

Deltamethrin insecticide was applied by air, at recommended field application rates (7.5 g/ha), to two prairie ponds in June, 1986. Larval and emerging Chironomidae densities were monitored in the treated ponds for 1 month prior to spraying, the remainder of the summer after spraying, and in the late part of the following spring. Following deltamethrin application, the density of chironomid larvae declined by two orders of magnitude in the treated ponds relative to the untreated ponds, with all genera being affected. Chironomid emergence declined in both the treated and untreated ponds. The pattern of recovery of the chironomid community was followed by multivariate analysis of larval genera abundances and qualitative comparisons of emerging species. The two treated ponds recovered at different rates: the community in one pond appeared to have recovered by 2 months after treatment, whereas that of the other treated pond showed little recovery until 1 year following treatment. In view of the high natural variation of chironomid communities and their habitats on the prairies, basic knowledge about these temporary pond ecosystems must be gathered in order to understand the long-term impact on such habitats of using deltamethrin and other insecticides. (Author's abstract)
W90-09290

EFFECT OF CELLULAR CARBOHYDRATE CONTENT AND NUTRIENT STATUS ON THE RESPIRATORY OXYGEN UPTAKE RATE OF A MICROCYSTIS POPULATION IN A EUTROPHIC POND.
Tokyo Metropolitan Univ. (Japan). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-09295

TEMPORAL AND SPATIAL VARIATIONS IN IRON CONCENTRATIONS OF TROPICAL BIVALVES DURING A DREDGING EVENT.
Newcastle upon Tyne Univ. (England). Dept. of Biology.
For primary bibliographic entry see Field 2L.
W90-09296

CONDITIONS OF THE PERACARID POPULATIONS OF SUBTIDAL COMMUNITIES IN NORTHERN BRITANNY TEN YEARS AFTER THE AMOCO CADIZ OIL SPILL.
Centre d'Etudes d'Oceanographie et de Biologie Marine, Roscoff (France).
J. C. Dauvin, and F. Gentil.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 3, p 123-130, 1990. 1 fig, 3 tab, 19 ref.

Descriptors: *Amphipods, *Benthic fauna, *Coastal waters, *France, *Oil pollution, *Oil spills, *Water pollution effects, Environmental effects, Marine pollution, Population dynamics.

The wreck of the Amoco Cadiz off the Portsall coasts (Northern Brittany, France) released 223,000 tons of oil into the marine environment in two weeks and polluted littoral and subtidal zones. Peracarid populations were greatly reduced by the 1978 spill. Ten years after the spill, a benthic survey was conducted in the soft-bottom infralittoral communities of the bays of Morlaix and Lannion and the Aber Wrac'h channel to study the state of recovery of peracarid populations. Living in isolated populations in fine sand and muddy sand communities with low potential for immigration, the recolonization and the reconstitution of these perturbed populations was expected to be slow. The amphipod populations from the subtidal channel of Aber Wrac'h, which were initially the most affected by the oil spill, were in the least advanced state of recovery. Some species present in abundance before the oil spill were not rediscovered. Nevertheless, ten years after the oil spill, most of the populations had completely recovered. (Mertz-PTT)
W90-09297

TRACE ELEMENT AND BIOTIC CHANGES FOLLOWING A SIMULATED OIL SPILL ON A MUDFLAT IN PORT VALDEZ, ALASKA.
Alaska Univ., Fairbanks. Inst. of Marine Science.
For primary bibliographic entry see Field 5B.
W90-09298

POLLUTION EFFECTS ON THE STRUCTURE OF MEIOFAUNAL COMMUNITIES IN THE BAY OF NAPLES.
Naples Univ. (Italy). Dipt. Genetica, Biologia Generale e Molecolare.
For primary bibliographic entry see Field 5A.
W90-09300

TOXIC EFFECTS OF SALINITY (S PPT) ON SOME FRESHWATER FISHES (IN CHINESE).
W. Zang, W. Wang, L. Ye, Z. Yu, and G. Ni.
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 20, No. 5, p 445-452, September 1989. 3 fig, 7 tab, 8 ref. English summary.

Descriptors: *Bioassay, *Carp, *Fish physiology, *Salinity, *Toxicity, Big head carp, Freshwater, Grass carp, Hydrogen ion concentration, Silver carp.

The toxic effects of salinity (S ppt) on some freshwater fishes were determined. Factors examined included the relationships between: (1) pH and LC50 of salinity for Silver carp (Hypophthalmichthyps molitrix C. et V.) fingerlings; (2) the growth rates of fries of Silver carp and Big head carp (Aristrichthys nobilis Richardson) and salinity; and (3) the egg ball diameters of Grass carp (Ctenopharyngodon ilellus C. et V.) and Silver carp and salinity. According to the results, the order of tolerance to salinity for the fish studied is: Big head carp > Grass carp > Blunt snout bream > Silver carp. The upper tolerance limit of Silver carp fingerling to salinity was about 1.5 ppt. (Author's abstract)
W90-09330

QSAR ANALYSIS OF THE ACUTE FISH TOXICITY OF ORGANIC PHOSPHOROTHIONATES USING THEORETICALLY DERIVED MOLECULAR DESCRIPTORS.
Fraunhofer-Inst. fuer Umweltchemie und Oekotoxikologie, Schmallenberg (Germany, F.R.).
G. Schuurmann.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 4, p 417-428, April 1990. 2 fig, 5 tab, 40 ref.

Descriptors: *Model studies, *Pesticides, *Structure-activity relationships, *Toxicity, Acute toxicity, Fish, Regression analysis.

The 14-d LC50 toxicity to the guppy of ten O,O-dimethyl O-phenyl phosphorothionate pesticides was analyzed with respect to linear two-parameter quantitative structure-activity relationship (QSAR) models containing partitioning and reactivity descriptors. The use of quantum chemical parameters within the modified neglect of diatomic overlap (MNDO) scheme leads to QSAR models with correlation coefficients up to 0.95 that are based solely on theoretically derived descriptors. The results show that quantum chemical descriptors have a particular value in modeling chemical reactivity within homologous series of compounds. (Author's abstract)
W90-09333

BACTERIAL MUTAGENICITY OF LEACHATE WATER FROM MUNICIPAL SEWAGE SLUDGE-AMENDED SOILS.
Texas A and M Univ., College Station. Dept. of

Soil and Crop Sciences.
K. C. Donnelly, K. W. Brown, and J. C. Thomas.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 4, p 443-451, April 1990. 5 tab, 31 ref. EPA Cooperative Agreement No. CR-812037-01.

Descriptors: *Groundwater pollution, *Leachates, *Mutagens, *Sludge disposal, *Soil amendments, *Water pollution sources, Bioassay, Land disposal, Lysimeters, Municipal wastewater.

A study was conducted to monitor the mutagenic potential of leachate from soils amended with municipal sewage sludge. The Salmonella/microsome assay was employed to monitor the mutagenicity of the organic extract of leachate collected from sludge-amended lysimeters containing undisturbed monoliths of Weswood silty clay (Fluventic Ustochrept) and Padina loamy sand (Grossarenic Paleustalf) soils. The sludge was applied to 18 barrel-sized lysimeters, while 6 unamended lysimeters served as controls. The leachate was concentrated on a combined XAD-2/XAD-7 resin, and the adsorbed organics were eluted with acetone. The leachate extracts were tested in the standard plate incorporation assay using strain TA98 with and without metabolic activation. Nine of 26 leachate extracts induced a positive response in the bioassay. The maximum specific activity was 207 net revertants per 10 mg induced without metabolic activation in the Weswood soil at the highest application rate (150 Mg/ha). The results suggest that land application of municipal sewage should be carefully managed to prevent leaching of mutagens into groundwater. (Author's abstract)
W90-09335

CONDITIONED AVERSION OF ALUMINUM SULFATE IN BLACK DUCKS.
Patuxent Wildlife Research Center, Laurel, MD.
For primary bibliographic entry see Field 5B.
W90-09339

EFFECT OF FENITROTHION ON THE FORAGING BEHAVIOR OF JUVENILE ATLANTIC SALMON.
Department of Fisheries and Oceans, St. John's (Newfoundland). Science Branch.
M. J. Morgan, and J. W. Kiceniuk.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 4, p 489-495, April 1990. 4 fig, 1 tab, 15 ref.

Descriptors: *Fenitrothion, *Fish behavior, *Insecticides, *Salmon, *Water pollution effects, Feeding rates, Predation.

Juvenile Atlantic salmon (Salmo salar) were exposed for 7 d to sublethal concentrations of technical grade fenitrothion and an operational formulation containing 11% fenitrothion. Foraging behavior of the salmon was then tested in a stream tank. Concentrations of 0.02 and 0.16 microliters/L of technical grade fenitrothion and the operational formulation containing 0.08 and 0.16 microliters/L of fenitrothion caused a significant decrease in the efficiency of the salmon's attach sequence. These concentrations, and a concentration of 0.005 microliters/L technical grade fenitrothion and 0.004 microliter/L fenitrothion in the operational spray, produced a significant decrease in the salmon's reaction distance to prey. All concentrations except 0.004 microliters/L fenitrothion in the operational formulation caused a significant decrease in the number of ingestions of prey made by the fish. These results suggest that foraging behavior in salmon is impaired by exposure to very low levels of fenitrothion. (Author's abstract)
W90-09341

EFFECT OF DISSOLVED OXYGEN AND THE MOLT STAGE ON THE ACUTE TOXICITY OF AMMONIA TO JUVENILE GREEN TIGER PRAWN PENAEUS SEMISULCATUS.
National Center for Mariculture, Elath (Israel).
N. Wajsbrot, A. Gasith, M. D. Krom, and T. M. Samocha.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 4, p 497-504, April 1990. 5

fig, 4 tab, 36 ref.

Descriptors: *Ammonia, *Shrimp, *Toxicity, *Water pollution effects, Acute toxicity, Bioassay, Crustaceans, Dissolved oxygen, Molt stage.

The mean 96-h LC50 value of ammonia for juvenile Penaeus semisulcatus (0.35-2.4 g) was 23.7 mg total ammonia-N (TAN)/L (19.3-28.7, 95% C.L.). There was no significant effect of size on the sensitivity of juvenile shrimp to ammonia. Increased toxicity of ammonia to juvenile P. semisulcatus was observed at dissolved oxygen (DO) levels below 55% saturation (3.7 ppm). At 27% DO saturation, the ammonia toxicity (96-h LC50) was doubled. In addition, the time of exposure to ammonia required for a given lethal effect decreased with reduced dissolved oxygen concentrations. Before and immediately after molt, the shrimp were more sensitive to ammonia. Due to the effect of the molt stage on the apparent ammonia toxicity, a minimum of 96-h bioassay is recommended for determining toxicity levels in shrimps. In a shorter period, the physiological changes occurring at the time of molting can confound the results of the experiment. (Author's abstract)
W90-09342

EFFECTS OF MUNICIPAL WASTEWATER DISCHARGES ON AQUATIC COMMUNITIES, BOISE RIVER, IDAHO.
Geological Survey, Boise, ID. Water Resources Div.
S. A. Frenzel.
Water Resources Bulletin WARBAQ, Vol. 26, No. 2, p 279-287, April 1990. 5 fig, 4 tab, 22 ref.

Descriptors: *Boise River, *Idaho, *Toxicity, *Trace elements, *Wastewater pollution, *Water pollution effects, Benthic fauna, Aquatic insects, Chronic toxicity, Fish, Mayflies, Wastewater treatment facilities.

Aquatic communities in the Boise River, Idaho, were examined from October 1987 to March 1988 to determine whether they were adversely affected by trace elements in effluents from two Boise wastewater treatment facilities. Trace-element concentrations in the Boise River were less than or near analytical-detection levels and were less than chronic toxicity criteria when detectable. Insect communities colonizing artificial substrates upstream and downstream from the wastewater treatment facilities were strongly associated, and coefficients of community loss indicated that effluents had benign enriching effects. The distributions of trace-element-intolerant mayflies indicated that trace-element concentrations in effluents did not adversely affect intolerant organisms in the Boise River. The condition factor, an index of well-being, of whitefish was significantly increased downstream from the Lander Street wastewater treatment facility and was significantly decreased downstream from the West Boise wastewater treatment facility. (Author's abstract)
W90-09352

ACID RAIN POLICY IN THE NETHERLANDS: APPLICATION OF MEDIATION TECHNIQUES.
Institute for Environment and Systems Analysis, Amsterdam (Netherlands).
M. W. L. Bovy, M. Mieras, G. H. M. M. J. Posma, P. J. M. Stallen, and K. Wieringa.
AMBIO AMBOCX, Vol. 18, No. 8, p 416-422, April 1989. 1 fig, 10 tab, 20 ref.

Descriptors: *Acid rain, *Environmental policy, *Social participation, *The Netherlands, *Water pollution effects, Administrative agencies, Air pollution control, Emission control, Policy making, Public participation, Water pollution control.

In the Netherlands, the Institute of Environment and Systems Analysis has been using mediation to formulate local and national policy on pollution control. Mediation involves meetings between the governmental agencies and representatives of the main societal sectors responsible for pollution. As an example of how to create and manage a mediation forum, the Clean Air Forum is analyzed from

the point of view of its organization, activities, and participants. The Clean Air Forum was held in order to establish realistic policies on acid rain reduction. As a result of mediation instead of legal action, the forum has succeeded in reducing industrial emissions of nitrogen oxides, sulfur dioxide, and ammonia through the use of current technologies and development of new technologies. (Marks-PTT)
W90-09359

ACID RAIN: CAUSE AND CONSEQUENCE.
Imperial Coll. of Science and Technology, London (England). Centre for Environmental Technology.
For primary bibliographic entry see Field 5B.
W90-09370

RECEIVING-WATER IMPACTS.
Limno-Tech, Inc., Ann Arbor, MI.
For primary bibliographic entry see Field 5G.
W90-09378

THEORETICAL AND EXPERIMENTAL DRAWBACKS IN HEAVY METAL SPECIATION IN NATURAL WATERS.
Pisa Univ. (Italy). Dipt. di Chimica.
P. Papoff, M. Betti, and R. Fuoco.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 301-323, 6 fig, 1 tab, 41 ref.

Descriptors: *Chemical speciation, *Heavy metals, *Toxicity, *Urban hydrology, *Water analysis, *Water chemistry, *Water pollution effects, Arsenic, Bioassay, Biological studies, Chromium, Laboratory methods, Natural waters, Path of pollutants, Reviews, Selenium.

Metals in natural waters are present either in soluble form, adsorbed, or retained in suspended or sedimented solid matter. The exchange of metals between different phases depends on the nature and size of the solids, and on some physico-chemical parameters intrinsic in each natural water. At present, the uptake mechanisms and the toxicity of different species in which the metal may be shared in the aquatic environment, are not well understood. All divalent transition metals and most electronegative metals react very promptly with the amino, imino and sulfhydryl groups of proteins; some of them (Cd, Hg) may compete with zinc and displace it in zinc-containing metalloenzymes. Experimental biological models are obtained by properly selecting for each parameter of interest: (1) the suitable biotic indicator; (2) the experimental laboratory conditions simulating the natural hydrosystem characteristics; and (3) the type of observable biological variable to be quantified (growth factor, nutrient uptake, etc.). Biologists' operative assumptions may be summarized as follows: (1) when heavy metal is shared in natural waters between different phases, the fraction present in the water phase, which includes colloids with a size diameter lower than 0.45 micron, is considered as the only one directly involved in biological uptake mechanisms. Suspended and sedimented matter are considered as a supply medium for heavy metal exchange; (2) the uptake of heavy metals may occur through three main pathways: (a) via the free metal ion; (b) by the displacement of the metal from an aqueous complex by means of a ligand group at the membrane interface; (c) by the direct crossing of the biological membrane through a proteic channel or as a hydrophobic and liposoluble metal complex; (3) the toxic activity of a free metal ion depends on the nature of the natural water; and (4) in the case of different states of oxidation, as for Se, Cr, As oxyacids, the toxic activity very much depends on the oxidation state. (See also W90-09381) (Lantz-PTT)
W90-09394

REGIONAL SIMULATION OF SURFACE WATER ACIDIFICATION: UNCERTAINTY

Group 5C—Effects Of Pollution

DUE TO SPECIFICATION OF ATMOSPHERIC DEPOSITION.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W90-09426

BULK PRECIPITATION DEPOSITION OF IN-ORGANIC CHEMICALS IN FOREST AREAS AND ITS INFLUENCE ON WATER QUALITY IN THE FEDERAL REPUBLIC OF GERMANY.
Hessian Forest Research Station, Hann. Muenden (Germany, F.R.). Inst. of Forest Hydrology.
For primary bibliographic entry see Field 5B.
W90-09433

EFFECTS OF ACID RAIN AND FOREST DIE-BACK ON GROUNDWATER--CASE STUDIES IN BAVARIA, GERMANY (FRG).
Bayerisches Landesamt fuer Wasserwirtschaft, Munich (Germany, F.R.).
T. Haarhoff.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 229-235, 5 fig, 4 ref.

Descriptors: *Acid rain effects, *Forest watersheds, *Groundwater pollution, *Water pollution effects, *West Germany, Acidification, Air pollution, Aluminum, Bavaria, Cadmium, Calcium, Case studies, Chromium, Groundwater quality, Hydrogen ion concentration, Magnesium, Sulfates.

Concern over increasing airborne pollution and the acceleration of water acidification has led to studies on the water balance and water quality in forest stands. In Bavaria, the forests are an important part of the natural environment, particularly with regard to the water balance. In 1986 investigations were initiated by the Bavarian Government into the effects of acid rain and forest die-back on the groundwater. The areas studied are: (1) Metzenbach/Birkwasser in the Spessart (red sandstone, locally weathered and weakened); (2) Markungsgraben in the Bavarian Forest (weathered granite and gneiss); (3) source brooks of the Lehstenbach in the Fichtelgebirge (granite blocks and weathered granite); and (4) Ebersberger Forest in the Munchner Schotterebene (Munich glacial gravel plain). Precipitation in the open areas in the Ebersberger Forest and in the Spessart showed similar concentrations but there were lower acid concentrations in the Ebersberger Forest. In the Spessart the seepage water is acidic over the whole two meters of the profile, but remains above 4.0 pH. Metal ion concentrations (aluminum up to 3 ppm; chromium, cadmium up to 20 ppb) registered in the already acidic surface soils (pH approx. 4.5), would jeopardize the water supply if they reached the groundwater. In the Ebersberger Forest the calcium-magnesium concentrations and the pH values increase rapidly below the decalcifying level (approx. 50 cm below the surface). In the Spessart, conductivity as a measure of the sum of dissolved ions in the observation period shows only minimal deviations in time and space, whereby individual ions vary widely in their concentrations. If pH values of 5-6 are regarded as natural, sulfate concentrations of 14-21 ppm suggest anthropogenic influences. The chalky gravel waters of the Ebersberger Forest have not yet been acidified but have been exposed to nitrate, sulfate and chloride from the atmosphere and from boundary inflow. (See also W90-09408) (Lantz-PTT)
W90-09434

PESTICIDES IN TERRESTRIAL AND AQUATIC ENVIRONMENTS.
For primary bibliographic entry see Field 5B.
W90-09440

EFFECTS OF THE INSECTICIDE METHOMYL ON DEVELOPMENT AND REGENERATION IN MEGALOPA AND JUVENILES OF THE MUD CRAB, RHITHROPANOPEUS HARRISII (GOULD).
Duke Univ., Beaufort, NC. Marine Lab.
A. S. Clare, and J. D. Costlow.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 3-16, 6 fig, 4 tab, 61 ref. DOE Grant 323-0098.

Descriptors: *Bioassay, *Carbamate pesticides, *Crabs, *Estuaries, *Insecticides, *Methomyl, *Teratogenic effects, *Water pollution effects, Biological studies, Ecotoxicology, Regeneration, Sublethal effects, Toxicity.

A bioassay has been developed to study sublethal effects of pesticides and to provide insight into their mode of toxic action in the decapod Crustacea. The bioassay involves autonomy of a single cheliped at the megalopal stage of the mud crab, Rhithropanopeus harrisii, with subsequent daily monitoring of regeneration during continual exposure to sea water solutions in the test compound. The bioassay data presented here are for the carbamate insecticide methomyl. With increasing concentration (150-250 ppb) of this acetylcholinesterase is an increase in mortality at each postlarval stage and an extended intermoult period in juvenile crabs. Methomyl also results in abnormal regeneration comprising either the absence of a regenerate or a regenerate which is small or malformed (teratogenesis). Thus, methomyl apparently exerts multiple effects, both acute and sublethal, on post larval mud crabs. (See also W90-09440) (Author's abstract)
W90-09441

BIOLOGICAL IMPACT OF WOOD TREATED WITH CHROMATED COPPER ARSENATE ON SELECTED ESTUARINE ORGANISMS.
New Jersey Medical School, Newark. Dept. of Anatomy.
P. Weis, J. S. Weis, and L. M. Coohill.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 19-28, 3 fig, 4 tab, 6 ref.

Descriptors: *Arsenic, *Chromated copper arsenate, *Copper, *Copper arsenate, *Crabs, *Estuarine environment, *Fungicides, *Killifish, *Water pollution effects, *Wood preservatives, Algae, Atomic absorption spectrophotometry, Biological studies, Ecotoxicology, Hardwood, Leaching, Seawater, Snails.

The effects of chromated copper arsenate (CCA), which is used for treating wood used in docks, pilings and bulkheads, were studied in several estuarine organisms. Leaching of metals from treated wood into sea water was assayed by atomic absorption spectrophotometry. Fiddler crabs (Uca pugilator) were subjected to limb removal and were placed in containers with treated wood of various sizes or control wood. The limb regeneration rate was retarded in a dose dependent fashion, and mortality occurred in the treated wood trial, reaching 100 percent in the tank containing the largest piece of treated wood. Embryos of the mummichog (Fundulus heteroclitus) were allowed to develop in culture dishes in which CCA treated or untreated wood was soaking. Mortality was noted in the dishes with treated wood and to a smaller extent in those with a large piece of untreated wood. Containers containing chromated copper arsenate treated wood, control wood or no wood were stocked first with the alga Ulva lactuca, then with snails (Nassarius obsoletus). The chlorophyll content of the algae was reduced in the treated wood within a few days. In the controls containing untreated wood or no wood, no such effects were seen. In all three types of experiments, the toxicity of the wood decreased over time. When the experiments were repeated with the same pieces of wood, effects were diminished due to decreased toxicity. (See also W90-09440) (Author's abstract)
W90-09442

USE OF GRASS SHRIMP (PALAEMONETES PUGIO) LARVAE IN FIELD BIOASSAYS OF

THE EFFECTS OF AGRICULTURAL RUNOFF INTO ESTUARIES.
Duke Univ., Beaufort, NC. Marine Lab.
For primary bibliographic entry see Field 5A.
W90-09443

SOS MICROTITRATION CHROMOTEST BIO-ASSAY FOR GENOTOXIC PESTICIDES.
Bowling Green State Univ., OH. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5A.
W90-09449

EVALUATION AND COMPARISON OF THE EXTRACTION PROCEDURE TOXICITY TEST (EP) AND TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR ANALYSIS OF PESTICIDES IN WASTE WATER SLUDGES.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5A.
W90-09460

TOXICITY TEST PROTOCOL FOR MATURE BIVALVE MUSSELS USING AUTOMATED BI-OLOGICAL MONITORING.
Tennessee Technological Univ., Cookeville. Dept. of Biology.
E. L. Morgan, P. Yokley, G. Rausina, J. R. Wright, and J. F. McFadden.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 259-264, 1 fig, 1 tab, 9 ref.

Descriptors: *Bioassay, *Bioindicators, *Monitoring, *Mussels, *Toxicity, *Water pollution effects, Automation, Biological studies, Fungicides, Lethal limit, Thiobencarb, Water quality control.

Mature freshwater mussels generally respond to adverse physical and chemical environmental impacts by withdrawing into closed shells for extended periods, thus making it difficult to conduct typical acute toxicity studies on these aquatic organisms. Furthermore, no clearly defined procedure is presently available for assessing the general physiological condition of mussels exposed to toxicants. A laboratory protocol for evaluating the functional state of mussels, as well as, accurately determining the time-to-death in mature mussels was developed as part of a preliminary screening study in which the fresh water mussel Potamilus purpuratus was exposed for twelve days to the fungicide thiobencarb. Each day an eight-level protocol was used to assess the functional state of each mussel while an automated electrophysiological monitoring system evaluated bioelectric activities of each animal, thereby accurately determining time-to death of the test animals. The protocol criteria for tactile response, siphon activity, and locomotion was found to be a relevant indicator of the general physiological condition of the mussels. Coupled with the automated electrophysiological monitoring system, the protocol provided a sensitive, non-destructive method for assessing both no-effect and effect concentrations of thiobencarb to mature freshwater mussels. In addition, the automated biosensing technique has the advantage of generating the interval and duration of exposure in toxicity tests where animals have the capacity to withdraw or isolate themselves from continued imposition. Time intervals thus derived could become critical elements in the dose/response relationship for a given toxin. Such values could be useful in helping define the maximum acceptable exposure that a given level of a potentially toxic chemical may be sustained in an ecologically sensitive population. (See also W90-09440) (Lantz-PTT)
W90-09461

TOXICITY OF SELECTED UNCOUPLING AND ACETYLCHOLINE ESTERASE-INHIBIT-ING PESTICIDES TO THE FATHEAD MINNOW (PIMEPHALES PROMELAS).

Wisconsin Univ.-Superior. Center for Lake Superior Environmental Studies.
For primary bibliographic entry see Field 5A.
W90-09465

MODELLING AGRICULTURAL PESTICIDE APPLICATION AND RISK FOR THE CHESAPEAKE BAY REGION OF VIRGINIA: CURRENT ESTIMATES, FUTURE TRENDS AND RESEARCH NEEDS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6A.
W90-09478

5D. Waste Treatment Processes

DESTRUCTION OF PESTICIDES AND THEIR FORMULATIONS IN WATER USING SHORT WAVELENGTH UV LIGHT.
California Univ., Davis. Dept. of Environmental Toxicology.
For primary bibliographic entry see Field 5F.
W90-08656

EFFECT OF EXCHANGEABLE CATIONS ON THE PERMEABILITY OF A BENTONITE TO BE USED IN A STABILIZATION POND LINER.
Sao Paulo Univ. (Brazil). Dept. of Chemical Engineering.
P. M. Buechler.
Water Science and Technology WSTED4, Vol. 22, No. 6, p 23-26, 1990. 2 fig, 6 ref.

Descriptors: *Bentonite, *Cation exchange, *Organic pollutants, *Sorption, *Wastewater treatment, Ammonium compounds, Interlamellar spacing, Isotherms, Molecular weight, Permeability.

The organophilic nature of bentonites exchanged with quaternary ammonium cations is used in sanitary engineering for the adsorption of organic pollutants. Five different quaternary ammonium cations are discussed: tetramethylammonium, trimethylstearylammonium, dimthylbenzyllaurylammonium, trimethylpalmitylammonium, and dimethyldistearylammonium. A Brazilian bentonite was treated with the above cations and the adsorption of vinasse organics was measured through the total organic carbon present in solution. The results show that the tetramethylammonium cation is the most effective of those tested to make sodium bentonite more organophilic, and the behavior follows a Freundlich isotherm. If the isotherms are plotted in milliequivalents of the cation over the weight of the sodium bentonite the present experiments did not show an appreciable difference in the quantity adsorbed. Therefore, if cost is a determining factor, low molecular weight cations should be chosen. The modified bentonites were characterized by the X-ray diffraction patterns. For high molecular weight cations the interlamellar spacing is close to 18 angstroms but for tetramethylammonium it is 13.5 angstroms. In any case, the replacement of sodium by a quaternary ammonium cation increases the capacity of the clay to adsorb organic molecules. (Author's abstract)
W90-08674

ASSESSMENT OF THE POTENTIAL FOR IN SITU BIOTREATMENT OF HYDROCARBON-CONTAMINATED SOILS.
Shell Research Ltd., Sittingbourne (England). Sittingbourne Research Centre.
P. Morgan, and R. J. Watkinson.
Water Science and Technology WSTED4, Vol. 22, No. 6, p 63-68, 1990. 4 fig, 2 tab, 5 ref.

Descriptors: *Biodegradation, *Cleanup operations, *Groundwater pollution, *Hydrocarbons, *Oil pollution, *Soil contamination, *Water pollution treatment, Microorganisms, Mineralization, Nutrients, Oil recovery, Sandy soils.

Enhanced in situ biotreatment is a recent technology for the cleanup of contaminated soil and groundwater but has not yet been tested for many contaminants. The assessment of three hydrocarbon-contaminated sites, one contaminated with crude oil, one with lubricating oil, and one with gasoline are described with respect to their potential for biotreatment. All locations were permeable, sandy soils which contained low concentrations of extractable inorganic macronutrients. Degradative microbial populations were present although their numbers were reduced in the most highly contaminated portions of the soil. Hydrocarbon analysis demonstrated that vertical penetration of contaminants into the soil was poor for the crude oil but had occurred at the other sites. There was some evidence that biodegradation at the crude and lubricating oil-contaminated sites may have occurred. The available data suggest that biotreatment of the lubricating and gasoline-contaminated sites by the provision of inorganic nutrients and oxygen to the soils might prove viable. However, the addition of inorganic nutrients resulted in an inhibition of mineralization in the soils. (Author's abstract)
W90-08679

REMOVAL AND UPTAKE OF COPPER (II) BY SALVINIA NATANS FROM WASTE WATER.
Visva-Bharati Univ., Santiniketan (India). Dept. of Chemistry.
A. K. Sen, and N. G. Mondal.
Water, Air and Soil Pollution WAPLAC, Vol. 49, No. 1/2, p 1-6, January 1990. 3 tab, 12 ref.

Descriptors: *Aquatic plants, *Artificial wetland treatment, *Bioaccumulation, *Copper, *Trace elements, *Wastewater treatment, Drinking water, Heavy metals.

Copper is a widely used valuable metal. It is an essential trace element, but it is toxic to plants, algae, and human beings at moderate levels. The permissible limit of copper (II) in drinking water is 1.0 micrograms/L. The sources of copper pollution are metal plating, industrial and domestic wastes, mining and mineral leaching. Recently aquatic plants have been used for the removal of heavy metals from water bodies. The plant, Salvinia natans L., was found to be very useful in the removal of copper (II) from wastewater. Effluents from the India Copper Complex, Hindustan Copper Ltd., Ghatshila, Bihar, India, which drain into the Subarnarekha River were collected and analyzed. The water was found to contain 0.75 to 1.2 microgram/ml of Cu(II). When 1 L of water was treated with 20 g of Salvana natans for one day, Cu(II) was completely removed and taken up by the plants from the water. Maximum accumulation was noted within one day and maximum removal (about 90%) was recorded below 50 micrograms/L of copper (II). The results indicate that the mode of uptake is possibly adsorption and the metal taken up by the plants forms stable complexes perhaps with the protein molecules within the plant in such way that once they (metal ions) are taken up, they cannot be brought back into solution without destruction of the plant. (Brunone-PTT)
W90-08685

DEFLUORIDATION OF WATER BY ADSORPTION ON FLY ASH.
Banaras Hindu Univ., Varanasi (India). Dept. of Applied Chemistry.
A. K. Chaturvedi, K. P. Yadava, K. C. Pathak, and V. N. Singh.
Water, Air and Soil Pollution WAPLAC, Vol. 49, No. 1/2, p 51-61, January 1990. 9 fig, 3 tab, 18 ref.

Descriptors: *Fluorides, *Fly ash, *Wastewater treatment, *Water treatment, Adsorption, Hydrogen ion concentration, Langmuir equation, Mathematical equations, Water temperature.

The ability of fly ash to remove fluoride from water and wastewaters has been studied at different concentrations, times, temperatures and pH of the solution. Removal of fluoride by adsorption on fly ash increases with time up to 120 minutes, thereafter, it becomes constant. With the increase in the initial fluoride concentration from 5 to 15 mg/L, the amount adsorbed increases from 0.2240 to 0.6150 mg/g while percentage of adsorption decreases from 89.6 to 82% at 30 C and 6.5 pH. With an increase in temperature from 30 to 50 C, using 10 mg/L of fluoride solution, the adsorption of fluoride increases from 0.4280 mg/g (85.60%) to 0.4700 mg/g (94%) at 6.5 pH. The distribution of fluoride between the solid-solution interface at equilibrium has been described by the Langmuir equation. The empirical mathematical relationship was tested with the help of kinetic data obtained from the batch adsorption technique at various fluoride concentrations. The removal of fluoride by adsorption on fly ash was found to increase from 79% to 94% with the change in pH of the fluoride solution (10 mg/L) from 2.0 to 6.5 at 30 C. (Brunone-PTT)
W90-08687

ESTIMATION METHOD OF RESIDUAL ALKYLATING AGENTS IN WATER TREATED WITH CHLORINE-CONTAINING OXIDANT.
Changsha Inst. of Tech. (China). Dept. of Applied Chemistry.
For primary bibliographic entry see Field 5B.
W90-08688

USE OF WOLLASTONITE IN THE REMOVAL OF NICKEL (II) FROM AQUEOUS SOLUTIONS.
Banaras Hindu Univ., Varanasi (India). Water Pollution Research Labs.
Y. C. Sharma, G. S. Gupta, G. Prasad, and D. C. Rupainwar.
Water, Air and Soil Pollution WAPLAC, Vol. 49, No. 1/2, p 69-79, January 1990. 6 fig, 3 tab, 34 ref.

Descriptors: *Adsorption, *Clay minerals, *Nickel, *Wastewater treatment, *Water pollution treatment, *Wollastonite, Acid-base dissolution, Isotherms, Langmuir equation, Solid-solution interface.

The ability of wollastonite an inexpensive clay mineral, to adsorb nickel (II) from water has been carried out. Used as an adsorbent in water pollution control, wollastonite is becoming a popular choice in water and wastewater treatment because of its low maintenance cost, simple design and easy operation. A removal of 92% of nickel (II) with 20 g/L of adsorbent was observed at 50 mg/L adsorbate concentration, 6.5 pH and 30 C. The process follows a first order rate kinetics with diffusion controlled nature and the data fits the Langmuir adsorption isotherm. Removal of nickel increases from 10 to 92% with the rise of pH from 3.0 to 8.0 and thereafter it remains almost unchanged. This change has been explained on the basis of aqueous-complex formation and the subsequent acid base dissolution at the solid-solution interface. (Author's abstract)
W90-08689

SLUDGE HEATING FOR ANAEROBIC DIGESTION.
North China Municipal Engineering Design Inst., Tianjin.
Z. M. Yu, Y. T. Hung, and H. H. Lo.
Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 23, No. 1, p 17-21, February 1990. 2 fig, 2 tab, 13 ref.

Descriptors: *Anaerobic digestion, *Heat exchangers, *Sludge treatment, *Temperature, *Wastewater treatment, Dewatering, Jacket type heat exchanger, Recirculation.

The effect of hot water and sludge on heat exchanger performance for sludge heating, using bench scale and pilot scale jacket type heat exchangers was determined. The temperature was controlled, constant for hot water and varying for influent sludge in the jacket type heat exchanger. A relatively constant temperature of sludge can be maintained in the anaerobic sludge digester with jacket type heat exchanger, leading to a better performance of sludge digestion. The average logarithmic temperature difference between hot water and sludge decreased with increasing temperature of sludge at constantly controlled heating of hot water. At constant temperatures of influent sludge, the logarithmic temperature difference increased

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with controlled heating of hot water. Since the jacket type heat exchanger was located outside of the digester, it was much easier to clean, repair, and maintain. The sludge was heated by recirculation and showed good dewatering characteristics with less sludge clogging. Since the sludge was able to be heated by the jacket exchanger at any time, a relatively constant temperature was maintained which which led to a better digester performance. Jacket type heat exchangers should be made of corrosion resistant materials because of the corrosive nature of the sludge. In addition, the cleanup outlet should be placed at the elbow of the tube in the jacket type heat exchanger. (Brunone-PTT)
W90-08694

BULKING SLUDGE CAUSING BACTERIA FROM SEWAGE TREATMENT PLANTS. I. METHODS FOR ENRICHMENT, ISOLATION AND CHARACTERIZATION (BLAHSCH-LAMM VERURSACHENDE BAKTERIEN AUS KLARANLAGEN. I. METHODEN ZUR ANREICHERUNG, ISOLIERUNG, UND CHARAKTERISIERUNG).
Technische Univ. Berlin (Germany, F.R.). Fachgebiet Hygiene.
V. M. Ziegler, and W. Dott.
Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 23, No. 1, p 22-31, February 1990. 2 fig, 2 tab, 70 ref. English summary.

Descriptors: *Bulking sludge, *Sewage bacteria, *Sludge treatment, *Wastewater treatment, Bacterial analysis, Bacterial physiology, Centrifugation, Culture techniques, Direct streaking, Filamentous bacteria.

The efficiency of different isolation methods and media was examined with 89 axenic cultures of filamentous bacteria from activated sludge (bulking sludge). The isolates were identified with morphological and cytological methods as strains of type 021 N, Sphaerotilus natans, Haliscomenobacter hydrossis, nocardioform Actinomycetes, pigmented colonies, and Bacillus sp. Centrifugation (pellet/supernatant), direct streaking, ultra turrax, and whirl mix, and the I-medium and AcS-medium, followed by the GS-medium methods were the most successful for isolating filamentous bacteria. (Author's abstract)
W90-08695

HAZARDOUS WASTE MINIMIZATION HANDBOOK.
For primary bibliographic entry see Field 5G.
W90-08749

SEPTIC TANK SYSTEMS.
National Building Research Inst., Pretoria (South Africa).
D. C. de Villiers.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-177570. Price codes: E04 in paper copy, A01 in microfiche. NBRI Special Report BOU 93, 1987. 17p, 7 fig, 12 tab, 3 ref.

Descriptors: *Design standards, *Septic tanks, *Subsurface filters, *Wastewater treatment, Absorption, Construction methods, Percolation, Subsurface drainage.

A septic tank system usually has two major components: the septic tank itself which is a watertight receptacle for all sewage and wastewater; and the liquid or effluent disposal system which in most cases is a subsurface soil absorption system. Each component has a specific function and should be designed accordingly. An efficient septic tank system should bring about the digestion of organic matter and discharge the effluent into the subsurface absorption field, where it is further treated by natural microbiological processes in the soil. Three aspects of septic systems are discussed: (1) the function, design and construction of the septic tank; (2) deals with subsurface absorption fields; and (3) mounded absorption systems. Solids and partially decomposed matter settle to the floor of the septic tank and accumulate as sludge, while

lightweight matter such as fats and grease rise to the surface and accumulate as scum. In this way three distinct layers develop in the tank: a layer of sludge at the bottom; a floating layer of scum; and a layer of reasonably clear liquid in between. Septic tank effluent can be treated in various ways. Percolation into the soil is the most common method of disposal, especially for small domestic systems, and conventional absorption fields warrant detailed discussion. Alternative ways in which the effluent can be treated include stabilization ponds, controlled irrigation, sand filtration and bio-disc systems. Mounded absorption systems can be suitable for areas with marginal soils, high groundwater tables, or insufficient soil depths. The two most important aspects of site selection are permeability of the soil and depth of the groundwater table. Mound systems are expensive because of the sand fill and they require a large amount of space. (Lantz-PTT)
W90-08761

IMPROVING STATE OUTREACH TO SMALL COMMUNITIES.
California Univ., Berkeley. Graduate School of Public Policy.
For primary bibliographic entry see Field 5G.
W90-08771

REMOVAL AND RECOVERY OF BERYLLIUM IN WATERS BY CHLORELLA VULGARIS.
New Mexico State Univ., Las Cruces. Dept. of Chemistry
P. L. Gatewood, and J. Sneddon.
Journal of Environmental Science and Health (A) JESEDU, Vol. 25, No. 1, p 21-28, January 1990. 1 fig, 3 tab, 8 ref.

Descriptors: *Beryllium, *Chlorella, *Pollutant removal, *Wastewater treatment, Hydrogen ion concentration, Industrial wastewater, Mine wastes, Performance evaluation, Spectrometry.

Using nitrous oxide-acetylene flame atomic absorption and direct-current argon plasma emission spectrometry to determine beryllium, the removal of beryllium from solutions and wastewater by Chlorella vulgaris was investigated. Binding depended on pH with maximum binding of over 80% occurring at a pH between 6 and 9. The binding was independent of the beryllium concentration in the range 0.05-2.7 microgram/ml. The effect of three separate matrices were investigated, with optimal binding of beryllium at pH 6.5 of 80% for sodium acetate, 65% for sodium carbonate, and 50% for deionized-distilled water. Using an industrial wastewater from a beryllium mining operation, which contained beryllium as ions and solid (beryllium (II) oxide), four pretreatments resulted in optimal binding ranging from 0 to over 95% (depending on the pretreatment (ie, form of beryllium)). pH reversal allowed nearly 100% recovery of the bound beryllium ($Be(2+)$ ions) back into solution from the Chlorella vulgaris. (Author's abstract)
W90-08960

ANODIC OXIDATION OF METHANOL IN A CIRCULATING FLOW BATCH REACTOR.
Kuwait Univ., Safat. Dept. of Chemical Engineering.
G. A. Al-Enezi.
Journal of Environmental Science and Health (A) JESEDU, Vol. 25, No. 1, p 67-79, January 1990. 4 fig, 2 tab, 9 ref. Kuwait University Research Council Grant EDC 019.

Descriptors: *Methanol, *Wastewater reactors, *Wastewater treatment, Anodic oxidation, Kinetics, Performance evaluation, Wastewater facilities.

The anodic oxidation of methanol in a circulating flow reactor was studied to determine experimental conditions required for a continuous fluidized bed reactor. The effects of applied current, initial alcohol concentration, and circulating flow rate on methanol conversion were investigated. The rate of methanol conversion increased with increasing applied current and decreased as initial alcohol concentration increased. A relationship between

methanol conversion and a combined effect of applied current and initial alcohol concentration was derived. The kinetics of the reaction was second order. Values of up to 85% methanol conversion were achieved. (Author's abstract)
W90-08963

METROPOLITAN WASTEWATER TREATMENT PLANT AND THE MISSISSIPPI RIVER: 50 YEARS OF IMPROVING WATER QUALITY.
Metropolitan Waste Control Commission, St. Paul, MN.
D. K. Johnson, and P. W. Aasen.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 134-138, Fall 1989. 5 fig, 8 ref.

Descriptors: *Dissolved oxygen, *Minnesota, *Mississippi River, *Municipal wastewater, *Wastewater, *Wastewater facilities, *Wastewater treatment, *Water pollution control, *Water quality, Aquatic insects, Bioindicators, Mayflies, Secondary wastewater treatment.

The Metropolitan Waste Control Commission and its predecessors have operated the Metropolitan Wastewater Treatment Plant on the Mississippi River at St. Paul, MN, for the past 50 years. Analysis of water quality data collected over the past 60 years shows a general improvement of water quality as the waste treatment process has been upgraded. In 1926, dissolved oxygen ranged from <1 milligram per liter (mg/L) to 2 mg/L in the river reach from St. Paul to Lock and Dam 3 (August mean values). In 1987, dissolved oxygen values in the same areas were 7 mg/L or greater. The drought of 1988 produced severe low flow conditions in the Mississippi River, but dissolved oxygen values continued to meet or exceed the 5 mg/L water quality standard. Biological sampling in 1926 and 1959 showed an absence of clean water organisms. Biological sampling in 1985 showed an abundance of clean water organisms. The most dramatic evidence of this resurgence is the reappearance of the Hexagenia mayfly in St. Paul after a 50 year absence. The water quality improvements in the Mississippi River correlate directly with improved treatment plant processes, particularly the current advanced secondary treatment facility, and with improved waste control throughout the Minneapolis/St. Paul area. (Author's abstract)
W90-08990

SIMULTANEOUS SLUDGE DRYING AND PELLETIZING.
Bio Gro Systems, Inc., Annapolis, MD.
M. J. Girovich.
Water Engineering and Management WENMD2, Vol. 137, No. 3, p 34, 36, 38-39, March 1990. 3 fig, 3 ref.

Descriptors: *Fluidized bed process, *Sludge disposal, *Sludge drying, *Sludge stabilization, *Sludge treatment, *Wastewater facilities, *Wastewater treatment, Belgium.

The world's first municipal sludge dewatering, drying, pelletizing, combustion, heat recovery and air-pollution control facility using an indirect multistage sludge dryer is located in the city of Bruges, Belgium. The plant has a capacity of 15-20 million gallons per day and serves a population of 300,000. The facility produces 2.6 dry metric tons of sludge per hour. The plant utilizes one of the three largest fluidized-bed furnaces in Europe; the furnace recovers energy from the flue gas to heat the fluidizing air up to 650 C. Ash is collected in an electrostatic precipitator and landfilled. Sludge is dried using an indirect method with a high thermal efficiency (75-80 percent). After pelletizing, the sludge is marketed as a fertilizer or an additive to fertilizers. (Tappert-PTT)
W90-08998

WORLD'S LARGEST EGG-SHAPED DIGESTERS.
Crom-RSB, Gainesville, FL.
G. Sutter, and C. S. Hanskat.

Water Environment & Technology WAETEJ, Vol. 2, No. 4, p 52-55, April 1990.

Descriptors: *Sludge digestion, *Sludge disposal, *Sludge treatment, *Wastewater facilities, *Wastewater treatment, Anaerobic digestion, Construction.

The world's largest prestressed concrete egg-shaped digesters are nearing completion in Bottrop, West Germany, as part of the construction of a central sludge handling facility for several wastewater plants. Each of the four digesters at the Bottrop site has a capacity of 15,000 cubic meters, is more than 45 m tall, and has a maximum diameter of 28 m at the mid-section, with wall thicknesses running from 0.40 m at the top cone section to 0.73 m at the cone bottom. Each digester was constructed in nine sections, and the structural concrete took 65 weeks to build, aided by prefabrication of the formwork for each section. The four digesters will operate in parallel as single-stage anaerobic reactors in the mesophilic temperature range, and are designed to handle a daily total raw sludge load of 3,000 cubic meters. (Tappert-PTT)
W90-09001

SLUDGE DISPOSAL USING LIME.
RDP Co., PLymouth Meeting, PA.
R. W. Christy.
Water Environment & Technology WAETEJ, Vol. 2, No. 4, p 56-61, April 1990. 2 ref.

Descriptors: *Lime, *Sludge disposal, *Sludge stabilization, *Sludge treatment, *Soil amendments, *Wastewater facilities, *Wastewater treatment, Costs, Operating costs, Pathogens.

It is estimated that the rate of sludge production will more than double by the year 2000. The wastewater treatment industry must therefore develop methods to treat the sludge so that it is more amenable to landfilling or, preferably, to produce a sludge that may be used as a soil amendment. A major concern over the application of wastewater sludge on soil is its pathogenicity. Biological processes are available to reduce pathogens and organic matter. Lime can be used to achieve a level of treatment equivalent to biological processes. Lime-stabilization offers many advantages when compared to digestion or composting, including lower operating costs, improved pathogen reduction, and ease of use. Important variables in designing the system include the quality and type of lime, the heat produced from the reaction and its use in the process reaction, the water-to-lime ratio, and the lime-to-dry-solids ratio. Operating cost of a lime-stabilization system is primarily that associated with the lime. The type and quantity of lime to be used, along with the mixer retention time, are critical to lime stabilization, and an on-site pilot test is recommended. (Tappert-PTT)
W90-09002

ANALYSIS OF HOLLOW FIBER BIOREACTOR WASTEWATER TREATMENT.
Cincinnati Univ., OH. Dept. of Chemical Engineering.
L. Dall-Bauman, S. Ilias, and R. Govind.
Biotechnology and Bioengineering BIBIAU, Vol. 35, No. 8, p 837-842, April 1990. 4 fig, 2 tab, 20 ref.

Descriptors: *Acetates, *Biofilm reactors, *Biological wastewater treatment, *Mathematical models, *Wastewater treatment, Finite element method, Substrates.

Public concern about potential environmental hazards associated with chemical wastes has grown in recent years and research into wastewater treatment has increased accordingly. Biological treatment of wastewater is an attractive alternative to other processes in that it offers the advantage of being a relatively clean technology. Hollow fiber bioreactors (HFBR) offer several theoretical advantages over existing fixed-film bioreactor support surfaces, including a high surface-to-volume ratio, separation of cells from flow, and high cell concentration. Tissue-like cell densities have been observed in some studies. A mathematical model describing the anaerobic biodegradation of acetate

in an HFBR is used to predict the results of a bench scale study of HFBR-based wastewater treatment. Model assumptions include a steady-state, isothermal system, axial concentration gradients negligible compared to radial gradients, and a film of uniform thickness and composition along the length of the fibers. These conditions normally hold at high recycle ratios. Each fiber is considered as a composite of three regions or phases: the fiber lumen, fiber wall, and biofilm. Orthogonal collocation on finite elements is the numerical technique used to convert the differential equations to algebraic equations. The model was run using different feed concentrations and biomass densities. The results suggest the amount of acetate that can be removed in a day is limited by the amount of biomass present. Acetate removal efficiency is increased with increasing biomass density, and acetate removal efficiency is decreased with increasing feed concentration. The model predicts that for a given set of parameters, HFBR could achieve 88% or better acetate removal from feed solutions containing 1.2 mM acetate. More concentrated feeds could be treated effectively if sufficiently high biomass density could be attained. (Tappert-PTT)
W90-09034

IMPACT OF 'GREENHOUSE EFFECT' ON SEWERAGE SYSTEMS.
Lund Univ. (Sweden). Dept. of Water Resources Engineering.
For primary bibliographic entry see Field 2A.
W90-09102

MESOPHILIC AND THERMOPHILIC AEROBIC DIGESTION OF MUNICIPAL SLUDGE IN AN AIRLIFT U-SHAPE BIOREACTOR.
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
R. D. Tyagi, F. T. Tran, and T. J. Agbebavi.
Biological Wastes BIWAED, Vol. 31, No. 4, p 251-266, 1990. 1 fig, 12 tab, 19 ref. EPA Grant EPA-600/2-82-002 (1982).

Descriptors: *Digestion, *Sludge digestion, *Wastewater reactors, *Wastewater treatment, Aerobic digestion, Airlift bioreactor, Biodegradation, Biological treatment, Mesophilic digestion, Oxygen transfer, Primary sludge, Sludge treatment, Thermophilic digestion.

Aerobic digestion of primary and secondary sludges was studied in airlift bioreactors at mesophilic and thermophilic temperatures. The experimental studies were conducted with a laboratory U-shape airlift reactor (operating volume 23 liters) and in a pilot U-shape airlift reactor of 1150 liters operating volume. In the laboratory reactor, with cold (6 C) and concentrated (3-4% solids) feed of primary and secondary municipal sludge, a 30% volatile suspended solids (VSS) reduction was achieved with a hydraulic retention time of 2.5 days. A VSS loading rate of 8.2 kg VSS/cu m/day was achieved. This loading is comparable to that obtained in a pure-oxygen sparged, mixed reactor. In the pilot plant reactor at mesophilic temperature (31-33 C), a VSS loading rate of 7.9 kg VSS/cu m/day and a VSS reduction of 40% were achieved with a hydraulic retention time of 4 days. (Author's abstract)
W90-09182

MONOD-BASED MODEL OF ATTACHED-GROWTH ANAEROBIC FERMENTERS.
Auburn Univ., AL. Dept. of Agricultural Engineering.
J. P. Bolte, and D. T. Hill.
Biological Wastes BIWAED, Vol. 31, No. 4, p 275-289, 1990. 3 fig, 4 tab, 27 ref.

Descriptors: *Anaerobic digestion, *Animal wastes, *Digestion, *Fermentation, *Mathematical models, *Model studies, *Waste treatment, *Wastewater treatment, Attached-growth fermentation, Biofilm reactors, Biological treatment, Dairy industry, Farm wastes, Feedlot wastes, Industrial wastes, Methanogenesis.

A mathematical model of steady-state attached-growth anaerobic fermentation kinetics was devel-

oped. It considers a single methanogenic culture following Monod growth kinetics. The five input parameters were (1) total influent volatile solids, (2) hydraulic flow rate through the reactor, (3) reactor fill ratio (support medium volume-total reactor volume), (4) operating temperature and (5) a waste-specific biodegradability constant. The waste-specific constants are given for swine, screened swine waste liquids, beef, dairy, poultry (broilers), and poultry (layers). The model is different from conventional suspended-growth reactor models by its explicit consideration of bacterial concentration in the reactor system, based on hydraulic flow and influent volatile solids concentration. The model was validated for treatment of swine and dairy waste liquids using data from both porous-media and solid-media attached growth fermenters. (Cassar-PTT)
W90-09183

STARTUP AND OPERATION OF AN ANAEROBIC BIOLOGICAL ACTIVATED CARBON (ANBAC) PROCESS FOR TREATMENT OF A HIGH STRENGTH MULTICOMPONENT INHIBITORY WASTEWATER.
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
J. G. Goeddertz, A. S. Weber, and W. Ying.
Environmental Progress ENVPDI, Vol. 9, No. 2, p 110-117, May 1990. 6 fig, 9 tab, 9 ref. N.Y. State Energy and Development Authority Agreement No. 869-EED-AEP-86.

Descriptors: *Activated carbon, *Anaerobic digestion, *Biological wastewater treatment, *Chemical wastewater, *Industrial wastewater, *Wastewater treatment, Anaerobic Biological Activated Carbon Pr, Formaldehyde, Methanol, Organic loading, Pilot plants.

A joint study was conducted to examine the feasibility of the anaerobic biological activated carbon (AnBAC) process for treatment of a high strength multicomponent inhibitory wastewater. The three principle components of the study waste were phenol, formaldehyde, and methanol. Bench-scale studies were conducted over a two-year period using 2.54 cm and 5.08 cm ID AnBAC columns. Based on the results of the bench scale studies, organic containment removal of greater than 90% was achieved at loading rates of 0.06 g COD/g GAC/day. To achieve optimal performance at these high loading rates, it was found that the anaerobic bacteria must be allowed to grow under noninhibitory conditions on the activated carbon for a period of close to one year. Efforts to speed up the growth process by increasing the organic loading rate resulted in inhibitory phenol concentrations, long term reduction in process efficiency, and possible process failure. Subsequently, the results from the bench-scale studies were used to design a pilot-scale AnBAC system which has been operating successfully for approximately ten months at a chemical plant in New York. Feasibility of the AnBAC process for treatment of a high strength inhibitory wastewater was successfully demonstrated. Stable operation with excellent organic removal was obtained at organic loading rates higher than reported previously in the literature. At a loading rate of 0.3 g COD/g GAC/day soluble long term COD removal of greater than 90% was obtained, with methane production close to the stoichiometric amount. Phenol removal in the pilot facilities exceeded 99%. (Chonka-PTT)
W90-09211

SEPARATION OF HAZARDOUS ORGANICS BY REVERSE OSMOSIS MEMBRANES.
Kentucky Univ., Lexington. Dept. of Chemical Engineering.
M. Williams, R. Deshmukh, and D. Bhattacharyya.
Environmental Progress ENVPDI, Vol. 9, No. 2, p 118-125, May 1990. 15 fig, 20 ref, U.S. EPA Cooperative Agreement No. CR814491.

Descriptors: *Chemical wastewater, *Hazardous wastes, *Membrane processes, *Ozonation, *Reverse osmosis, *Separation techniques, *Wastewater treatment, Batch adsorption, Hydrocarbons, Hydrogen ion concentration, Phenols.

Experimental studies showed that thin-film, composite membranes can be used effectively for the separation of selected hazardous organic compounds. This waste treatment technique offers advantages in terms of high solute separations at low pressure and broad pH operating range, and the use of charged membranes would allow the selective separation of some organics from feeds containing high salt concentrations. The two membranes studied, a charged nanofiltration membrane (NF40) and a low pressure reverse osmosis membrane (FT30), had water fluxes of .001 to .0013 cm/s at 1.4 M Pa; NaCl and Na(2)SO(4) rejections were 30% and 97%, respectively, for the NF40 membrane and 96% and 97%, respectively, for the FT30 membrane. For the ionizable compounds (chlorophenols) studied, flux drops were highly dependent upon feed pH. The NF40 membrane flux drop was 17.4% at feed pH 3, but less than 6% at pH 9 for trichlorophenol, and over 30% at pH 3 while only 3.7% at pH 7.0 for a chlorophenol-chloroethane mixture. The FT30 membrane flux drop with trichlorophenol decreased from 27.9% at pH 3 to 4.3% at pH 9.4, and from 44.8% at pH 3.0 to less than 12% at pH greater than 7.9 for the chlorophenol-chroloethane mixture. In addition, feed pre-ozonation of selected organics provided significant improvement in flux and rejection characteristics for both charged and uncharged membranes due to the formation of ionizable organic acid intermediates during the ozonation that do not interact as strongly with the membrane. The overall ozonation-membrane process could be greatly effective in producing permeate water of high quality while minimizing the volume of waste that must be further treated. (Chonka-PTT)
W90-09212

EMPLOYEE INVOLVEMENT AND ENVIRONMENTAL EXCELLENCE.
R. Gorsline.
Public Works PUWOAH, Vol. 121, No. 5, p 70-71, May 1990.

Descriptors: *Maintenance, *Management planning, *Operating policies, *Wastewater facilities, Employee relations, Maintenance costs, Texas.

Early in 1988, the wastewater treatment plant of Lamesa, Texas was in need of extensive modifications. The arid west Texas city of 11,790 had been served by the plant for almost 25 years with no major modifications and only routine repairs. The task at hand seemed to indicate an expensive cleanout of the anaerobic digester, possible replacement of the dome, and the construction of additional sludge drying beds. Because of the financial stress that accompanied a simultaneous downturn in the area's oil and agriculture economy, the city decided to seek other alternatives before committing major expenditures. After examining several options, it was decided to try a polymer injection system. The polymer was injected into the sludge stream after leaving the digester. The installation of a new lab, at a cost of approximately $10,000 has led to the plant being operated effectively and efficiently within its design parameters. After only relatively minor repairs and fine tuning, it was discovered that most of the major expenditures were not warranted. To maintain and assure an optimum level of operations and long term reliability in all the department's operations, a preventive maintenance program was initiated. An additional maintenance crew was formed to take care of plant maintenance. The key ingredient in the program is employee involvement and commitment to excellence. Energy conservation is optimized by operating the plant within the design parameters. This allows the use of more efficient pump cycles. The installation of new automatic controls and the preventive maintenance program with the use of specified lubricants have also contributed to the plant's conservation of energy. (Chonka-PTT)
W90-09229

EFFICIENT DEGRADATION OF TRICHLOROETHYLENE BY A RECOMBINANT ESCHERICHIA COLI.
Amgen, Thousand Oaks, CA.
For primary bibliographic entry see Field 5G.
W90-09231

COMPARISON OF MODELS FOR PREDICTING SLURRY PRODUCTION ON A PIG FARM.
AFRC Inst. of Engineering Research, Silsoe (England).
A. G. Williams, and W. V. Streader.
Biological Wastes BIWAED, Vol. 31, No. 3, p 187-197, 1990. 5 fig, 3 tab, 6 ref.

Descriptors: *Farm wastes, *Feedlot wastes, *Slurries, *Wastewater, Comparison studies, Digestibility, Dry matter, Estimating, Pig slurry, Pigs.

Three methods of predicting slurry production were compared with the values actually produced on a 150 sow breeding and fattening pig unit. The methods were based on (1) feed, water and slurry relationships measured in crated and penned pigs; (2) values given in the literature and used to predict slurry outputs from pigs; and (3) a method based on the digestibility of feed and of water measured at the actual piggery. The feed, water and slurry relationships method was not found appropriate because of the high overall water:meal ratio in the unit (13:1). The method based on literature values for predicting slurry outputs was able to predict dry matter production accurately, but underestimated the volume produced unless the allowance of 0.5 L/pig/day for washing water and leaking drinkers was increased to 10 L. The digestibility method was the best method for estimating volume but underestimated dry matter production. Combining the better aspects of the literature values method and the digestibility method allows volume, dry matter production and dry matter concentration to be predicted satisfactorily. The daily movements of slurry from the reception pit were very variable. The use of water meters on pig units is recommended to identify wastage. (Author's abstract)
W90-09284

ENHANCEMENT OF DRY ANAEROBIC BATCH DIGESTION OF THE ORGANIC FRACTION OF MUNICIPAL SOLID WASTE BY AN AEROBIC PRETREATMENT STEP.
Agricultural Univ., Wageningen (Netherlands).
Dept. of Water Pollution Control.
For primary bibliographic entry see Field 5E.
W90-09285

EVALUATION OF VARIOUS FLOCCULANTS FOR THE RECOVERY OF ALGAL BIOMASS GROWN ON PIG-WASTE.
Laval Univ., Quebec. Groupe de Recherche en Recyclage Biologique et Aquiculture.
G. Buelna, K. K. Bhattarai, J. de la Noue, and E. P. Taiganides.
Biological Wastes BIWAED, Vol. 31, No. 3, p 211-222, 1990. 8 fig, 2 tab, 28 ref.

Descriptors: *Algae harvesting, *Biological wastewater treatment, *Polymers, *Wastewater treatment, *Wastewater utilization, Algae, Biomass, CR 400, Chitosan, Chlorella, Chlorophyta, Farm wastes, Pig wastes, Polyacrylamides, Zetag 63.

By combining controlled biomass production with wastewater treatment, it should be possible to contribute to the simultaneous solution of two major problems: food supply and protection of the environment. A study evaluated the use of the natural polymer chitosan (by-product derived from shrimp and crab shells) and of synthetic polymers, as flocculants for the recovery of algal biomass grown on pig-waste. Laboratory experiments were conducted to compare the effectiveness of chitosan, Zetag 63 and CR 400 (hydrolyzed polyacrylamides) as flocculants to concentrate a mixed culture of chlorophyceae dominated by Chlorell speces. The algae were grown in a high-rate algal pond fed with dilute pig-waste. Algal sedimentation rates were measured in the laboratory. For a pH range of 6.0-9.0, flocculation efficiency of 95-100% was obtained at 20 mg/L chitosan and 5 mg/L Zetag 63. The optimum range of initial biomass concentration for maximum algal recovery was found to be 100-200 mg dry weight algae/L. (Mertz-PTT)

W90-09286

ANAEROBIC DIGESTION OF PIG MANURE MIXED WITH SEWAGE SLUDGE.
Hong Kong Baptist Coll., Kowloon. Dept. of Biology.
M. H. Wong.
Biological Wastes BIWAED, Vol. 31, No. 3, p 223-230, 1990. 2 tab, 19 ref.

Descriptors: *Anaerobic digestion, *Farm wastes, *Hong Kong, *Sludge digestion, *Wastewater treatment, Activated sludge, Fermentation, Methane, Organic matter, Pigs, Raw sludge, Sludge.

Pig manure plus sewage sludge was treated by anaerobic digestion, using batch fermentation at 37 C. Pig manure was collected from the Kadoorie Experimental Extension Farm in the New Territories of Hong Kong. Samples of raw sludge and surplus activated-sludge were collected from the Shatin Sewage Treatment Plant, Hong Kong. A portion of the collected manure was composted for 5 days. The moisture content of the composted manure was then adjusted to about 90% using distilled water. The diluted slurry was placed in a digester for 30 days at 37 C before being used as seeding material. The results indicated that the digested materials contained a lower level of putrescible matter when compared to the raw materials. Co-digestion of pig manure and sewage sludge at the ratio of 2:1 seemed to give the best results in terms of reducing the organic load and yielding a higher volume of methane. It is recommended that this experiment be repeated in digestion tanks of a sewage treatment plant, especially for treating pig manure which has been recognized as the major source of water pollution in Hong Kong. (Mertz-PTT)
W90-09287

MICROBIOLOGICAL ASPECTS OF ANAEROBIC DIGESTION OF SWINE SLURRY IN UPFLOW FIXED-BED DIGESTERS WITH DIFFERENT PACKING MATERIALS.
Milan Univ. (Italy). Sezione di Microbiologia Agraria.
C. Sorlini, G. Ranalli, S. Merlo, and P. Bonfanti.
Biological Wastes BIWAED, Vol. 31, No. 3, p 231-239, 1990. 4 fig, 2 tab, 16 ref.

Descriptors: *Anaerobic digestion, *Biogas, *Farm wastes, *Microbiological studies, *Wastewater treatment, Bacteria, Clays, Digestion, Fermentation, Methane, Pig wastes, Polyvinyl chloride, Wastewater, Wood wastes.

Diluted livestock slurry such as that found from swine breeding farms where water is widely used for the cleaning of the building yards, is generally treated in aerobic biological plants. Microbiological research has been conducted on fixed-bed anaerobic digesters containing support matrices of different shapes and materials. Samples taken from liquid influents, liquid effluents, bottom sediments and biofilms attached to the supports of three laboratory anaerobic, fixed-bed, upflow digesters, filled with wood chips, PVC (polyvinyl chloride) or expanded-clay support media and fed with swine slurry, were tested microbiologically. The numbers of anaerobic heterotrophic, anaerobic cellulolytic, acidogenic-peptone-glucose fermenting and methanogenic bacteria were determined. For each digester the biogas production was monitored. The highest biogas production, referred to the volatile solids concentration in the feed, was obtained in the digester with wood chips, while production was almost nil in the digester with expanded clay. In all digesters, considerable numbers of the microorganisms responsible for digestion do not attach to the support materials but remain suspended in the liquid and the numbers of the different microbial groups in the effluents from the three digesters were similar. The digester with wood chips proved the most suitable for the production of methane. (Mertz-PTT)
W90-09288

SITE ASSESSMENTS FOR REAL ESTATE TRANSACTIONS.

Parsons, Brinckerhoff, Quade and Douglas, Inc., Denver, CO.
For primary bibliographic entry see Field 5G.
W90-09309

STUDIES ON COPPER REMOVAL BY LIGNIN SOLUTION/SUSPENSION.

Metallurgical and Engineering Consultants (India) Ltd., Ranchi.
K. V. R. Varma, T. Swaminathan, and P. V. R. Subrahmanyam.
Journal of Environmental Science and Health (A) JESEDU, Vol. 24, No. 8, p 847-861, 1989. 3 fig, 3 tab, 15 ref.

Descriptors: *Copper, *Heavy metals, *Lignin, *Metal complexes, *Waste treatment, *Wastewater treatment, Heavy metal removal, Hydrogen ion concentration.

The increasing awareness of the potential environmental impacts of heavy metal pollution and the techno-economic limitations of conventional metal removal techniques have led to the study of alternative, inexpensive methods. Lignin, a readily available polymer from pulp and paper industry wastes, appears to be an attractive material for heavy metal removal. Copper removal by lignin is affected by both copper and lignin solution pH as well as the lignin dose. Copper removal is also markedly influenced by the extent of lignin in suspension and the final pH of the filtrate. Maximum (95%) Cu removal was obtained with both lignin and copper solution pH at 5.5 and a lignin dose of about 1 g/L. The optimum final pH corresponding to maximum Cu removal was between 4.4 and 5.0. Inhibition by hydrogen ions at low pH and dissolution of the lignin-metal complex at higher pH result in poor copper removals. (Author's abstract)
W90-09318

INVESTIGATION OF HAZARDOUS CHARACTERISTICS OF REFINERY WASTEWATER SLUDGES.

Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-09319

AEROBIC TREATMENT OF MOLASSES DISTILLERY WASTE WATER AND BIOMASS PRODUCTION.

National Research Centre, Cairo (Egypt).
A. M. Azzam, and Y. A. Heikel.
Journal of Environmental Science and Health (A) JESEDU, Vol. 24, No. 8, p 967-978, 1989. 4 tab, 19 ref.

Descriptors: *Biological treatment, *Food-processing wastes, *Microbial degradation, *Molasses, *Wastewater treatment, Amino acids, Biomass, Chemical oxygen demand, Egypt, Sugarcane.

Molasses stillage, a byproduct of the sugar cane industry in Egypt, was treated with Candida utilis and Paecilomyces voriotii used separately and in a mixed culture in a two step aerobic batch process. The distillery wastewater was treated with C. utilis in the first step and with P. variotii in the second step, which was carried out on the supernatant from the first step. The total reduction of the chemical oxygen demand (COD) was 90% using the mixed culture. The produced biomass was 22 g/L using the mixed culture with a productivity of about 0.5 g/L/h. Using C. utilis the biomass produced was 18 g/L and the reduction of the COD was 45%. Using P. variotii the biomass produced was 5 g/L and the reduction in COD was 70%. The chemical composition and the amino acid content as well as the biological value of the produced biomass were measured. The amino acid profiles were very similar to FAO reference protein, but with a low content of methionine and cystine and a high content of leusine, lysine and threonine. (Author's abstract)
W90-09322

CONTROL AND TREATMENT OF COMBINED-SEWER OVERFLOWS.

Van Nostrand Reinhold, New York. 1990. 226p. Edited by Peter E. Moffa.

Descriptors: *Combined sewer overflows, *Storm water management, *Storm-overflow sewers, *Urban hydrology, *Wastewater treatment, *Water pollution prevention, Case studies, Management planning, Mathematical models, Regulations, Water quality.

When it rains, the combined stormwater and sanitary wastes carried by combined sewers is diverted from a community's wastewater treatment plant directly to receiving waters, creating a severe water-pollution problem. Five leading CSO experts provide the practical guidance that enables practitioners to effectively combined sewer overflow (CSO) problem characterize the quantity and quality of CSO discharges; develop mathematical models of sewer systems for projections of CSOs during various rainfalls; determine water quality impact from CSOs using field measurements and modeling; and understand the full range of available control and treatment technologies in order to select those that best combat the specific problem at hand. The book then illustrates how to develop a cost-effective abatement plan, building on the information provided in the chapters. Numerous case histories involving sewer systems in both small communities and large metropolitan areas offer further insight into workable control, maintenance, and treatment techniques. Also, a look at the options open to federal and state governments and regulatory agencies in dealing with the CSO problem illustrates what part they can play in combatting this problem. (See W90-09376 thru W90-09380) (Lantz-PTT)
W90-09375

COMBINED SEWER OVERFLOWS: CONTROL AND TREATMENT.

For primary bibliographic entry see Field 5G.
W90-09379

METALS CONTROL TECHNOLOGY: PAST, PRESENT AND FUTURE.

Illinois Inst. of Tech., Chicago.
J. W. Patterson.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 27-42, 8 tab, 45 ref.

Descriptors: *Chemical treatment, *Inorganic compounds, *Metals, *Sludge treatment, *Urban hydrology, *Waste disposal, *Wastewater treatment, *Water pollution prevention, Adsorption, Chemical precipitation, Ion exchange, Oxidation, Reduction.

Industrial pollutants can be broadly categorized into organic compounds and inorganic compounds. At the most fundamental level, the most protective method to avoid adverse environmental impacts for industrial organic pollutants is to destroy these compounds, by biological or thermal oxidation, converting them to carbon dioxide and associated oxidation products. When other options are chosen for these industrial organics, such as landfill or atmospheric release, the problem shifts from a localized to a dispersed problem, amplifying the adverse effects and the consequent costs, for remediation. With inorganic toxic pollutants, there are no available destructive technologies, nor natural environmental assimilative capacity as there are for most industrial organic compounds. Thus, management strategies must be formulated within a context of those options available for safe environmental management. Metal control technologies currently available are: precipitation; oxidation/precipitation; reduction/precipitation; coagulation/co-precipitation; ion exchange; and adsorption. The treatment residue (the sludge) however, is simply not disposable in a safe environmental manner. The available array of opportunities for sludge management involve three basic strategies to eliminate or reduce the masses of metal sludges now disposed

into the environment: source avoidance or reduction; direct metals concentration and selective recovery for reuse, from the waste stream; and selective metallurgical extraction of metals for recovery and reuse, from sludges. (See also W90-09381) (Lantz-PTT)
W90-09383

METAL SPECIATION IN SLUDGES FROM WASTEWATERS TREATMENT BY BULK AND SURFACE (XPS) ANALYSIS.

Basilicata Univ., Potenza (Italy). Inst. of Chemistry.
E. Desimoni, A. Marcone, G. Tiravanti, and P. G. Zambonin.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 45-68, 10 fig, 4 tab, 32 ref.

Descriptors: *Chemical analysis, *Chemical speciation, *Metals, *Sludge treatment, *Urban hydrology, *Wastewater treatment, *X-ray spectroscopy, Cadmium, Chemical precipitation, Hydrogen ion concentration, Mercury.

Surface analysis techniques seem to represent a valid aid in interpreting the complex precipitation processes from wastewaters. X-ray Photoelectron Spectroscopy (XPS) in particular, allows investigation of the different speciation chemistry of the metals, even with complex substrates such as polymeric sludges. The results obtained in this study, integrated with information on the bulk chemistry, allow the elucidation of the precipitation micromechanisms by focusing the attention at the outermost surface layers, e.g. the most active sites of the polymeric sludge. The method is based on the use of semisynthetic polymers (e.g. starch xanthate), as precipitation of silver can be interpreted on the basis of a simple model, involving the precipitation of a mixture of metal sulfides and xanthates whose composition is controlled by the pH of the wastewater specimen. Analysis of the data relevant to the precipitation of Hg(II) and Cd(II) suggests that side reactions can play an important role in the precipitation process. By this approach, it was possible to ascertain the presence and the non-homogeneous distribution of species hypothesized on the basis of bulk elemental ratios and to give a reasonable interpretation of the different precipitation kinetics of the studied toxic metals, in terms of the different role played by surface oxygenated species unexpectedly on the basis of bulk analysis. (See also W90-09381) (Author's abstract)
W90-09384

NUCLEATION AND CRYSTAL GROWTH STUDIES ON PRECIPITATION OF CADMIUM HYDROXIDE FROM AQUEOUS SOLUTIONS.

Illinois Inst. of Tech., Chicago.
J. W. Patterson, B. Luo, D. Marani, and R. Passino.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 91-113, 8 fig, 2 tab, 35 ref.

Descriptors: *Cadmium, *Chemical analysis, *Chemical precipitation, *Chemical speciation, *Crystallization, *Nucleation, *Urban hydrology, *Wastewater treatment, Chemical properties, Kinetics, Particle size, Physical properties.

Preliminary results of a study designed to improve the knowledge of the fundamental principles governing cadmium hydroxide precipitation, as well as the subsequent solid/liquid separation processes in wastewater treatment, are presented. In particular, this study addressed the kinetics of Cd(OH)2 precipitation in terms of nucleation and crystal growth rates. Physical characteristics of the precipitate particles were studied in terms of surface charge and particle size distribution. Cd(OH)2 precipitation was investigated both in the absence and in the presence of citric acid as a model inhibiting

agent. Preliminary results show that Cd(OH)2 precipitation is very fast in the absence of an inhibiting agent. In this instance, completely stirred tank reactor tests seem to be more appropriate than batch tests for kinetic studies. At low base/metal molar ratios, the precipitate is stabilized in a colloidal form by a positive surface charge. In agreement with classical nucleation theory, the nucleation rate was found to be highly dependent on the supersaturation. (See also W90-09381) (Author's abstract)
W90-09386

EXPERIMENTS ON THE SIMULTANEOUS OXIDIZING EXTRACTION PROCESS OF FE(II).
Oviedo Univ. (Spain). Dept. of Chemical Engineering.
J. M. Diaz, A. E. Fernandez, A. T. Aguayo, and J. Viguri.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 149-164, 9 fig, 10 ref.

Descriptors: *Chemical precipitation, *Chemical speciation, *Iron, *Metal complexes, *Oxidation, *Urban hydrology, *Wastewater treatment, Chemical reactions, Chemical treatment, Heavy metals, Kinetics.

Iron elimination from aqueous solution is commonly carried out both in the treatment of wastewater and in the post-leaching step of hydrometallurgical processes. Dissolved iron in natural waters, generally attributed to the dissolution of rocks and minerals, usually increases because the streams from several industrial, mining or domestic wastewater which flow into them are loaded with dissolved iron. Most of the methods proposed for iron removal require a previous oxidation to ensure that all the metal present is in the ferric form, more easily separable than the ferrous one. In natural water, it is common to remove the iron solved by precipitation of a ferric salt and subsequent filtration. An experimental method using a acetylacetone, an organic complexant and extractant which was dissolved in toluene. Atmospheric oxygen was used as the oxidant. When a simultaneous process of oxidation and extraction takes place, the Fe(II) is oxidized to Fe(III) and complexed with acetylacetone. A considerable advantage of the process is the autoregulation of pH, thus there is no precipitation of ferric salts. Consequently instead of a solid by-product after stripping, a concentrated solution of Fe(III) remains from which one could try to achieve the recovery of iron. Further analysis of this method will require a separate study of oxidation of Fe(II) by air flow and a subsequent study of the extraction kinetics of Fe(III). (See also W90-09381) (Lantz-PTT)
W90-09388

HYDROLYSIS, PRECIPITATION AND AGING OF COPPER(II) IN THE PRESENCE OF NITRATE.
Illinois Inst. of Tech., Chicago. Dept. of Environmental Engineering.
J. W. Patterson, R. E. Boice, C. Petropoulou, D. Marani, and G. Macchi.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 169-1977, 10 fig, 5 tab, 33 ref.

Descriptors: *Chemical precipitation, *Chemical speciation, *Copper, *Hydrolysis, *Metal complexes, *Nitrates, *Urban hydrology, *Wastewater treatment, Chemical reactions, Chemical treatment.

The widely applied alkaline precipitation process for Cu(II) removal from wastewaters involves a complex set of concurrent and sequential phenomena. In this study, two series of batch Cu(II) precipitation tests have been performed through the mixing of base (NaOH) with metal solutions, at

Cu(NO3)2 concentration levels of 0.5 mM and 5 mM. Results obtained in 0.5 mM Cu(NO3)2 solutions suggest that cupric hydroxy nitrate may preferentially precipitate during the first part of slow addition of base to metal solution. Further addition of base induces conditions favorable for precipitation of hydroxide, while the previously formed basic salt is converted in hydroxide as well. Soon after completion of reagents mixing, a slow aging process is evidence in the stirred suspension by changes in pH, conductivity, turbidity, free and soluble copper concentrate. Eventually, after months of aging, the properties of the suspensions resulted in close agreement with those theoretically predicted for cupric oxide systems. Potentiometric measurements on aged precipitate suspensions are consistent, within the experimental error, with reported solubility products for cupric oxide. Results obtained in 5 mM Cu(NO3)2 solutions show that, at low base/metal molar ratios, stable cupric hydroxy nitrate is produced upon aging. This seems to be in contrast with theoretical predictions, which indicate that, even at such high nitrate concentrations, cupric oxide is the most stable solid phase. Potentiometric measurements on such aged suspensions indicate systems undersaturated with respect to the basic salt, but oversaturated with respect to cupric oxide. This investigation points out the importance of the aging phenomenon on chemical composition and physicochemical characteristics of Cu(II). In industrial practice, in which relatively short residence times are allowed for precipitation to occur, intermediate forms can be even more important than the thermodynamically stable precipitates. (See also W90-09381) (Lantz-PTT)
W90-09389

ROLE OF COPPER COMPLEXATION ON TREATMENT EFFICIENCY AND DESIGN OF TWO INDUSTRIAL WASTESTREAMS.
K. Saranteas, and I. W. Wei.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 203-225, 18 fig, 6 tab, 17 ref.

Descriptors: *Chemical speciation, *Chemical treatment, *Copper, *Hydrogen ion concentration, *Industrial wastewater, *Urban hydrology, *Wastewater treatment, Chemical precipitation, Heavy metals, Inorganic compounds, Sulfides, Waste recovery.

An organo-metallic dye manufacturing process train generates two major copper containing wastestreams: the acidic waste, pH 0.45, and the basic waste, pH 13.5. Preliminary bench scale tests indicate that chemical precipitation by sulfide or hydroxide techniques is only effective for the acidic stream while activated carbon treatment is only effective for the basic stream. Potentiometric and treatment results show that the reason for such treatment selectivity is that copper exists in its free ion/inorganic complex form for the precipitation favorable acidic waste while it exists in its organometallic form for the carbon favorable basic waste. A segregated stream treatment is proposed for pilot studies, and is expected to yield copper removal at > 99% levels for both streams. (See also W90-09381) (Author's abstract)
W90-09390

POLYELECTROLYTIC METAL IONS SEQUESTRANTS.
ENEA, Rome (Italy).
L. Campanella, V. Crescenzi, M. Dentini, C. Fabiani, and F. Mazzei.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 359-372, 8 fig, 2 tab, 9 ref.

Descriptors: *Chemical treatment, *Polyelectrolytes, *Urban hydrology, *Wastewater treatment, Bacteria, Chemical properties, Heavy metals, Maleic acid, Metal speciation, Metals, Polymers, Sequestrants, Synthetic compounds.

Toxic metals can be removed from wastewaters by different, traditional procedures such as the precipitation of oxides, hydroxides, sulfites or carbonates, ion exchange, adsorption and electrodeposition or membrane processes. More recently, procedures for the removal of heavy metal ions from aqueous media based on the use of polyelectrolytes, either synthetic or natural, have been the subject of active investigation. These species may exhibit at the same time a very high metal binding capacity--often accompanied by complex precipitation--and the ability to focculate colloidal, suspended particles quantitatively. Polyelectrolytes may also be used in immobilized form, i.e. entrapped in water insoluble, stable polymeric membranes. In an attempt to make such procedures both efficient and economically attractive, different polyelectrolytes have been considered including biopolymeric derivatives (e.g. starch derivatives). Research has recently been started on the possible use of metal ion sequestrants of maleic acid 1:1 copolymers as well as of ionic polysaccharides from nonpathogenic bacteria. Maleic acid copolymers, on the other hand, while not biodegradable can be prepared from relatively inexpensive raw materials, and present a high hydrolytic stability making them usable under experimental conditions prohibitive for the biopolymers. The extent of Cr(III) and Cu(II) ions complexation by the three polyelectrolytes considered (a 1:1 maleic acid-ethyl vinyl ether copolymer; a 1:1 maleic acid-acrylic acid (MAAA) copolymer; and the exocellular polysaccharide extracted from cultures of Rhizobium trifolii) is very high, particularly so in the case of the MAAA copolymer. This is consistently shown by potentiometric, equilibrium dialysis, spectroscopic and calorimetric data indicating that the main driving force is entropic in nature in all cases. (See also W90-09381) (Lantz-PTT)
W90-09396

PROCESS TO IMPROVE THE REGENERATED EFFLUENT CONCENTRATION OF ION EXCHANGE.
Seventh Design and Research Inst., Xian (China).
L. Xiang, and D. Peng.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 399-405, 3 fig, 2 tab, 1 ref.

Descriptors: *Industrial wastewater, *Ion exchange, *Metal-finishing wastes, *Regeneration, *Urban hydrology, *Wastewater renovation, *Wastewater treatment, Chemical treatment, China, Regenerated water, Water reuse.

Wastewater from metal finishing and plating industries usually contains a lot of metals, such as copper, zinc, cadmium, nickel, and chromium. Many methods have been developed to treat this kind of wastewater, but ion exchange seems to be the primary candidate because it can eliminate pollution and recover metal and the treated water can be reused. In China, more than one thousand sets of ion exchange equipment have been installed since 1975. However, some problems have arisen in use, especially the management of regenerated effluent. In this study a limited regenerated effluent concentration formula was used to assist in the selection of regenerating liquid concentration. A step by step regeneration process is introduced whereby the regenerated effluent concentration can be increased, and the regeneration process can be operated in optimum conditions. Evaporators can be omitted when this process is used for the recovery of chromates and other metals from plating wastewater. The regenerated effluent can be directly refilled to the plating bath. The initial and final portions cut from regenerated effluent can be reused as regenerating influent after a solid or highly concentrated regenerating agent is added. The specific consumption of the regenerating agent is then reduced. (See also W90-09381) (Lantz-PTT)
W90-09398

HEAVY METAL REMOVAL USING NATURAL ZEOLITE.

National Technical Univ., Athens (Greece).
M. D. Loizidou.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 417-433, 8 fig, 9 tab, 15 ref.

Descriptors: *Heavy metals, *Ion exchange, *Metal-finishing wastes, *Urban hydrology, *Wastewater treatment, *Zeolites, Cation exchange, Clinoptilolite, Industrial wastewater, Regeneration.

The removal of heavy metals from industrial effluents is drawing an increased interest. It is well known that the presence of toxic metals in the environment is a potential health hazard. From a study that has been carried out for the Athens area, concerning the metal plating and metal finishing industries, it was found that around 150 small plants exist and produce effluents that contain very high metal concentrations. For the heavy metal removal from aqueous solutions or effluents, several physicochemical methods have been used, such as: precipitation, activated carbon adsorption, ion exchange, reverse osmosis, foam flotation techniques, and cementation. Needs to keep methods low in cost have prompted the study of an effective and low-cost method for removing the toxic cations from the effluents by using naturally occurring materials, the so-called zeolites. Zeolites have the ability to exchange cations, like the organic resins. In this study, several ion exchange systems were examined using the natural zeolite, clinoptilolite, in order to evaluate its efficacy for the treatment of effluent containing heavy metals such as lead, cadmium, zinc, copper, nickel, iron and chromium. Results indicate that clinoptilolite has quite a high ion exchange capacity. Metal removal percentage is quite satisfactory and the selectivity series for the various cations does not change when the external solution concentration changes. The actual exchange capacity of the zeolite is much lower compared with the theoretical one, indicating that for these particular experimental conditions, the entering cations do not occupy all the available positions in the crystal. This partial ion exchange is very common in natural zeolites. The regeneration process indicates that significant amounts of the metal taken, could be released in an exchange with sodium. (See also W90-09381) (Lantz-PTT)
W90-09399

METAL ION SEPARATIONS FROM HAZARDOUS WASTE STREAMS BY IMPREGNATED CERAMIC MEMBRANES.

Syracuse Univ., NY. Dept. of Chemical Engineering and Materials Science.
J. Yi, R. Ferreira, and L. L. Tavlarides.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 437-451, 6 fig, 1 tab, 17 ref. New York State Center for Hazardous Waste Management Grant 150-W012A.

Descriptors: *Ceramic membrane, *Hazardous wastes, *Membrane processes, *Metals, *Separation techniques, *Urban hydrology, *Wastewater treatment, Chemical treatment, Heavy metals, Ion exchange, Membranes, Metal-finishing wastes, Spectrophotometry.

The objective of this research was to determine the feasibility of an advanced separation technology to extract metal ions selectively from aqueous waste streams by ceramic membranes impregnated with organic chelation acids. To provide experimental information to test the concept, a rotating diffusion cell (RDC) was employed with on-line UV-visible spectrophotometry to provide flux data under well characterized hydrodynamic mass transfer conditions. Meaningful flux data have been obtained using the RDC to test the concept using a synthetic sample to mimic a dilute copper aqueous waste stream. The trial membrane system was an alpha-alumina/silica membrane (0.2 cm thick, 49-55 micron average pore size, and 41.7 volume % porosity) impregnated with a 100%, 2-M $(Cu(++))$ in sulfate solution of pH 5, copper metal flux values of 0.117 and 0.482 mgmol/sq cm/hr were obtained with disk rotating speeds of 200 and 350 rpm. These results are reproducible and prove the validity of the experimental technique and the concept of metal ion separation via impregnated ceramic membranes. Membrane modules of shell and tube configurations are also envisioned feasible for multiple metal ion separation systems. Assuming that adequate fluxes can be obtained, the use of several membrane modules arranged in an appropriate sequence with proper choice of chelation acids will selectively remove metals from hazardous multiple metal ion streams. This capability of producing concentrated specific metal streams will permit the recovery and recycle of many metal ions. (See also W90-09381) (Author's abstract)
W90-09400

CHEMICAL DECONTAMINATION OF DREDGED MATERIALS, SLUDGES, COMBUSTION RESIDUES, SOILS AND OTHER MATERIALS CONTAMINATED WITH HEAVY METALS.

Heidelberg Univ. (Germany, F.R.). Inst. fuer Sedimentforschung.
G. Muller.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 477-489, 6 fig, 1 tab, 12 ref.

Descriptors: *Decontamination, *Dredging wastes, *Heavy metals, *Sludge treatment, *Urban hydrology, Cadmium, Copper, Hydrogen ion concentration, Ion exchange, River sediments, Soil contamination, Zinc.

In recent years great environmental problems have arisen in the disposal and storage of dredged materials heavily contaminated with heavy metals, especially since the high cadmium concentrations that occur in many of these materials do not allow uncontrolled disposal or use in agriculture. Similar problems exist with metal polluted sewage sludge, fly ash, residues from combustion and pyrolysis with soils that have been exposed to heavy metal emissions or have been treated with contaminated materials. Two categories of techniques can be distinguished: Type A--large scale concentration techniques; and Type B--decontamination or concentration techniques for relatively small-scale operations. Among the A-techniques (classification, flotation, high gradient magnetic separation) only classification is applicable to dredged sediments or soils contaminated with heavy metals. Among the B-techniques considered to be applicable to dredged sediments contaminated with heavy metals (NaOCl-leaching, ion exchange, acid leaching) NaOCl-leaching is restricted to mercury if present in the sludge in a form oxidizable with hypochlorite, i.e., as a sulfide or an organic compound. Where ion exchange is concerned, three mutually independent developments run parallel: selective cation exchange through existing, complex-forming cation exchangers, development of new selective ion exchangers, and strongly basic anion exchangers. The most promising results are from laboratory experiments obtained with strongly basic anion exchangers after acid extraction. Metals may be mobilized through pH reduction. When the chloride concentration is sufficiently high in the liquid phase, metals such as Cd, Zn and Cu show a tendency to dissolve as negatively charged chloride complexes. In this form the metals may be immobilized by a strongly basic anion exchanger, which is in chloride form. (See also W90-09381) (Lantz-PTT)
W90-09402

RESULTS OF BENCH-SCALE RESEARCH EFFORTS TO WASH CONTAMINATED SOILS AT BATTERY-RECYCLING FACILITIES.

PEI Associates, Inc., Cincinnati, OH.
For primary bibliographic entry see Field 5G.
W90-09403

THREE CASE STUDIES OF WASTE MINIMIZATION THROUGH USE OF METAL RECOVERY PROCESSES.

Environmental Protection Agency, Cincinnati, OH.
M. L. Apel, J. Bridges, M. F. Szabo, and S. H. Ambekar.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 517-541, 3 fig, 4 tab, 17 ref.

Descriptors: *Case studies, *Heavy metals, *Metal-finishing wastes, *Urban hydrology, *Waste recovery, *Wastewater treatment, Aluminum, Ammonium carbonate, Chemical precipitation, Chemical treatment, Copper, Industrial wastewater, Leaching, Lead, Metals, Wash water.

Wastewater is the largest source of waste in most metal-finishing facilities, and easily the largest in printed circuit board manufacturing facilities and radiator repair shops. Copper, nickel, lead, zinc, and tin are the contaminants most commonly found in these wastewaters. Several technologies are being developed to recover metals from the wastewater. The technologies involve the use of principles of extraction, ultrafiltration, ion exchange, electrochemistry, membrane separation, and others. The case studies considered in this chapter involve: (1) a spray rinse system; (2) recovery of copper and lead from metal-finishing waste streams by aluminum displacement; and (3) recovery of copper and lead from wastewaters generated in radiator repair shops by use of a nonelectrolytic process. Preliminary tests have shown that cooling the hot caustic radiator boilout solution and adding sodium sulfide will precipitate the metal hydroxides. The precipitates are coarse enough to settle out of the solution and leave a stripped, clarified liquid. Approximately 80% of the solution can then be recycled. These results also indicate that copper can be effectively separated from radiator boilout tank sludge by a single leaching with ammonium carbonate. Ammonium carbonate leaching would be the most effective on the earthy, sandy sludges produced by the traditional process, while sodium sulfide treatment would be the most effective for the flocculent sludges produced in the ultrasonic boilout tanks. In the area of heavy metals, it may now be the time to begin implementation of the following concepts: (1) to condition the heavy metal sludges for resource recovery at the generator level; and (2) to develop the processing technology for heavy metal resource recovery at the economics-to-scale for the intermediate collector and processor level. (See also W90-09381) (Lantz-PTT)
W90-09404

METRO RECOVERY SYSTEMS--A CENTRALIZED METALS RECOVERY AND TREATMENT FACILITY IN TWIN CITIES, U.S.A.

Lancy International, Inc., Warrendale, PA.
J. J. Chen.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 547-564, 2 fig, 5 tab, 7 ref.

Descriptors: *Heavy metals, *Minneapolis, *St Paul, *Urban hydrology, *Waste recovery, *Wastewater treatment, *Water management, Chemical treatment, Ion exchange, Minnesota, Regeneration, Sludge dewatering, Sludge drying, Water transport.

A new national waste management strategy is being formulated in the United States motivated by regulatory requirements and cost saving necessity. The central treatment and recovery facility (CTRF) was discussed to fit the new strategy after a thorough evaluation based on technical, economical and market factors. A unique coalition of

regulatory agencies, metal finishing organization, environmental engineering industries and the public has brought the CTRF concept to reality in the Twin Cities. The dilute rinse streams are concentrated by ion exchange resin in portable canisters at the customers' sites. The spent canisters are then trucked to the facility for regeneration. The regenerants and concentrate are processed for materials recovery and reclamation. The nonrecoverable wastes are treated as required to produce acceptable effluent for discharge to sewer. All sludges generated at the customers' sites are currently mechanically dewatered and thermally dried for ultimate disposal in classified landfills. However, CTRF is designed with the flexibility of extracting metals for recovery from sludges using acid treatment and adding sludge fixation/stabilization steps to accommodate requirements of the land ban legislation. Organic liquids are also accepted for temporary storage for ultimate processing at an organic solvent or oil recovery facility, or disposal by incineration off site. CTRF will provide direct cost savings both capital and operation expenditures to the users. It will reduce potential liability to the customer because by means of metals recovery the sludge production is reduced, and sludge stabilization may transform the metal hydroxide sludge to a nonhazardous state. (See also W90-09381) (Lantz-PTT)
W90-09405

RECOVERY OF METALS FROM WASTE STREAMS BY HYDROMETALLURGICAL PROCESSES.

Metalinstituut TNO, Apeldoorn (Netherlands).
C. L. van Deelen.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 567-583, 4 fig, 4 tab, 7 ref.

Descriptors: *Chemical treatment, *Heavy metals, *Metallurgy, *Urban hydrology, *Waste recovery, *Wastewater treatment, Aluminum, Electrolysis, Incineration, Ion exchange, Leaching, Solvent extraction, Sulfides, Water transport.

A processing route, developed in the Netherlands has proven successful for the removal of heavy metals from a number of waste streams and the recovery of individual metal components as salable products. The process is based on hydrometallurgical principles and can be applied to both solid and liquid waste streams. Spent hydrodesulfurizing (HDS)-catalyst from oil refineries is brought to the site either in drums or in bulk containers and is transferred to a feeding bunker. From there catalyst is fed into a rotary calciner to burn off carbon and hydrocarbons and to convert the metal sulfides into their oxides. Flue gas from the rotary calciner must be treated with lime or an alkaline solution to remove the sulfur dioxide that is formed during oxidizing of the metal sulfides. After the thermal treatment a sieving step is carried out to remove ceramic balls that have been used as support material in the desulfurizing reactor. In the next stage of the process the treated catalyst is leached with diluted sulfuric acid at an elevated temperature, extracting cobalt, nickel, molybdenum, vanadium (if present) and part of the alumina carrier. The residue from the leaching step is washed and dried and can be sold as alumina source. The residue is 60-70% of the feed stock, depending on the composition of the spent HDS-catalyst. The remaining leachate contains all metals, including some of the alumina, at levels varying from 0.5 to 25 g/L in a sulfate environment, the acidity reaching a level of pH 0 to 2. The metals are recovered from the leachate using a combination of solvent extraction, ion exchange and electrolysis. (See also W90-09381) (Lantz-PTT)
W90-09406

CHROMIUM RECOVERY FROM TANNERY SLUDGE BY INCINERATION AND ACID EXTRACTION.

Rome Univ. (Italy). Dept. of Chemistry.
M. Beccari, L. Campanella, E. Cardarelli, M. Majone, and E. Rolle.

IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 587-602, 10 tab, 11 ref.

Descriptors: *Chromium, *Incineration, *Tannery wastes, *Urban hydrology, *Wastewater treatment, Chemical recovery, Heavy metals, Hydrogen ion concentration, Industrial wastewater, Oxidation, Sludge treatment.

Investigations of the state of the art of treatment/disposal of tannery sludges has shown that an interesting method for selectively recovering chromium from the sludges, to permit recycling within the tannery, consists of oxidative incineration followed by chromate extraction, reduction to Cr(III), residue stabilization, and disposal of the inert ashes in a non-special controlled discharge. Ad hoc experiments have been carried out to evaluate process feasibility. Incineration tests have shown that in the 600-800 C temperature range, Cr(III) oxidation takes place with high yields (about 80%) without the need for additional reagents (provided that the Cr/Ca weight ratio in the sludges to be treated is $<$ or $=$ 0.30-0.35, as in most tannery sludges) or with high oxygen excess. A contact time of 1 hr is sufficient, at pH 3-6, to extract a very large aliquot in the form of Cr(VI) of the total chromium originally contained in the sludge even for comparatively high ashes/extracting solution ratios (up to 6-7%). The corresponding acid consumption has been found to be quite low (5-10 kg of 100% H2SO4/kg of chromium actually extracted). The results obtained in preliminary extraction tests combined with a simultaneous reduction of the Cr(VI) extracted are promising in the light of the environmental hazards associated with the leachability of Cr(VI) from the residual ashes. On the basis of these favorable results an adequately parameterized model will be developed for the purpose of predicting performance as a function of a given set of adopted conditions and which will, therefore, allow a cost-benefits analysis to be made of the process under optimal operating conditions, also taking environmental constraints into account. (See also W90-09381) (Lantz-PTT)
W90-09407

DISPOSAL OF DILUTE AND CONCENTRATED AGRICULTURAL PESTICIDES USING ABSORPTION AND CHEMICAL AND MICROBIAL DEGRADATION.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
G. H. Hetzel, D. E. Mullens, R. W. Young, and J. M. Simonds.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 239-248, 1 fig, 7 tab, 11 ref.

Descriptors: *Absorption, *Agricultural chemicals, *Biodegradation, *Composting, *Pesticides, *Waste disposal, *Wastewater treatment, Adsorption, Diazinon, Microbial degradation.

A disposal process for diluted or concentrated agricultural pesticide solutions in two phases: (1) an absorption phase during which pesticide laden solutions are mixed with organic absorbents, and (2) a disposal phase involving separation of the absorbent plus absorbed pesticide from the purified solution is revealed. The absorbent is then placed into a composting environment during which the pesticides are degraded. A laboratory manual has been developed that is being used to determine the absorption rate of certain pesticides on organic materials. It has been found that removal of certain pesticides from aqueous solutions using peat moss can be quite significant. For example, diazinon levels of 10,000 mg/Kg (200 ml) can be reduced to 55 mg/Kg when mixed with 5 grams of peat moss for 24 hours. Field studies have provided information to develop protocols for disposing of several pesticides by using biodegradation/composting methods. Very high levels of diazinon can be degraded with in a short time. Levels ranging from 4,000 to 32,000 mg/Kg were effectively degraded

to less than 0.2 percent in eighteen weeks. Multiple applications of relatively large amounts of diazinon applied over extended time intervals have resulted in similar rates of degradation. Laboratory and field studies have led to the development of an apparatus to field-test the pesticide disposal model system, which might prove useful to a wide variety of pesticide users. This apparatus is designed to process up to 40 gallons of pesticide wastewater using peat moss as the primary pesticide absorbent. (See also W90-09440) (Author's abstract)
W90-09459

INSECTICIDES FOR INSECT PEST CONTROL IN CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT: A DILEMMA.

Tennessee Valley Authority, Muscle Shoals, AL. Vector and Plant Management Program.
E. L. Snoddy, and J. C. Cooney.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 440-443, 2 fig, 10 ref.

Descriptors: *Pesticides, *Wastewater treatment, *Wetlands, Acid mine drainage, Aquatic plants, Cattails, Domestic wastewater, Macrophytes, Mosquitoes, Organophosphorus pesticides.

The utilization of macrophytes for both primary and secondary wastewater treatment is a relatively new technology now being utilized for domestic sewage, certain industrial discharges, and acid mine drainage. Some of the major insect problems associated with these facilities include mosquitoes and other biting flies produced as a result of facility construction and operation, and plant feeding insects that may destroy the planted flora. The macrophytes utilized in these constructed wetlands, particularly the cattail Typha latifolia, are subject to severe depredation by the armyworm complex. In order to control this pest, insecticides must be applied immediately upon discovery of this insect on the plants. An operational case study, which describes this particular problem and the use of organophosphorus (OP) insecticides for the control of the cattail army worm Simyra henrici (Lepidoptera: Noctuidae) is presented. The treatments and observations were made in acid drainage treatment wetlands at Widow's Creek Steam-Electric Plant, Stevenson, Alabama. (See also W90-09440) (Author's abstract)
W90-09470

SEPTIC TANK EFFLUENT QUALITY AND DETERGENTS.

Wisconsin Univ., Madison. Water Resources Center.
B. J. Alhajjar, G. Chesters, and J. M. Harkin.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 151-165, 3 tab, 11 ref.

Descriptors: *Detergents, *Effluents, *Septic tanks, *Wastewater treatment, *Water pollution control, Bioindicators, Calcium, Magnesium, Monitoring, Nitrogen, Phosphates, Potassium, Regression analysis, Sodium, Statistical models.

Chemical and biological characteristics of septic tank effluent (STE) were measured in samples taken for 2 yr from two groups of septic systems to determine the potential of groundwater pollution by nitrogen, phosphates, soluble ions, indicator bacteria, solids, and surfactants. One group of eight septic systems received wastewater with phosphate (PO4) detergent, and the other group of nine with carbonate (CO3) detergent. The data were evaluated statistically. Multiple regression models were used to investigate STE quality of the two groups of septic systems in relation to detergent type. Concentrations of cations such as sodium, potassium, calcium and magnesium and anions such as chloride and ortho phosphates; electrical conductivity; alkalinity; total, total suspended, total volatile, and volatile suspended solids; biological oxygen demand; and total counts of indicator bac-

teria were significantly higher in STE obtained from households using PO4-detergent. Better removal of nitrogen in the septic tank is achieved with the use of PO4-detergent. (See also W90-09479) (Author's abstract)
W90-09491

ONSITE COMBINED IN-GROUND AND VESSEL ADVANCED TREATMENT OF WASTEWATER FROM COMMERCIAL GENERATORS.
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
J. P. Martin, K. J. Zitomer, and D. Caballero.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 181-195, 7 fig, 2 tab, 19 ref.

Descriptors: *In situ treatment, *Municipal wastewater, *Wastewater treatment, Aeration, Denitrification, Filtration, Hospitals, Industrial wastewater, Infiltration, Septic tanks, Soil disposal fields.

Groundwater is the major drinking water source on the New Jersey Shore, such that effluent standards for large onsite wastewater disposal systems include a maximum of 10 mg/L of nitrate as nitrate nitrogen. Alternative systems for onsite nitrogen removal from wastewaters are described at two sites where treated effluent is discharged to groundwater though sand mound infiltration fields at each site. At a nursing home, a 12,000 gallons/day (gpd) extended aeration-denitrification plant was installed. However, difficult wastewater characteristics impeded startup of the plant. Fortunately, treatment occurring in the infiltration field was adequate to meet discharge standards, but a combination of factors caused premature hydraulic failure. A shopping center, with an 11,000 gpd design flow, has a more spacious site that allowed installation of a less mechanically complex and innovative system of in-ground treatment units. The goals were flexible and economic operation, and resistance to seasonal shock or low flows. Included were parallel series of septic shock or low flows. Included were parallel series of septic tanks, buried sand filters, pumping stations, added-carbon denitrification tanks, and numerous points where wastewater under treatment could be monitored and the process adjusted if desired. The solution used at each site represents a balance between meeting the effluent quality standards, the need for economical operation, and the local social-political conditions. (See also W90-09479) (Lantz-PTT)
W90-09493

HYDROCARBON REMOVAL FROM GROUND WATER-DESIGN CONSIDERATIONS AT LEAKING UNDERGROUND STORAGE TANK SITES.
Stover and Bentley, Inc., Stillwater, OK.
For primary bibliographic entry see Field 5G.
W90-09512

5E. Ultimate Disposal Of Wastes

POLYCHAETE POPULATION DYNAMICS AND PRODUCTION IN THE NEW YORK BIGHT ASSOCIATED WITH VARIABLE LEVELS OF SEDIMENT CONTAMINATION.
National Marine Fisheries Service, Highlands, NJ. Sandy Hook Lab.
For primary bibliographic entry see Field 5C.
W90-08720

NUTRIENT ACCUMULATION IN TREES AND SOIL FOLLOWING IRRIGATION WITH MUNICIPAL EFFLUENT IN AUSTRALIA.
Victoria Dept. of Conservation, Forests and Lands, State Forests and Lands Service, Melbourne (Australia).
For primary bibliographic entry see Field 3C.
W90-08732

HAZARDOUS WASTE MINIMIZATION HANDBOOK.
For primary bibliographic entry see Field 5G.
W90-08749

PRINCIPLES OF HAZARDOUS MATERIALS MANAGEMENT.
R. D. Griffin.
Lewis Publishers, Inc., Chelsea, Michigan. 1988. 207p.

Descriptors: *Air pollution effects, *Hazardous wastes, *Path of pollutants, *Public health, *Regulations, *Waste management, Air pollution, Federal jurisdiction, Groundwater pollution, Risk analysis, Waste disposal, Waste treatment, Water pollution effects.

By the early 20th century, exposures to minerals and dusts from smelters, gases from coal and oil combustion, and vapors from oil refining and chemical processing caused the average citizen to begin feeling the effects formerly experienced occupationally by industrial workers. Today the challenge is to determine the risks of potentially hazardous materials from the point of origin through usage to final destination, whether in a discarded material or as a trace contaminant in air, water, or food supplies. How chemical contaminants affect human health (Chapters 1 through 3), and how they are transported (Chapters 4 through 6), measured (Chapter 7), managed (Chapters 8 and 9), and regulated (Appendices) are covered in this book. (Lantz-PTT)
W90-08751

CONSIDERATIONS FOR REDUCING THE COST OF TESTING DREDGED MATERIAL.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
J. C. Pennington, T. R. Higgins, B. L. Folsom, and D. L. Brandon.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report D-90-7, April 1990. Final Report. 22p, 4 tab, 14 ref.

Descriptors: *Bioassay, *Chemical analysis, *Costs, *Dredging wastes, *Economic aspects, *Pollutant identification, *Waste disposal, *Waste management, Decision making, Management planning, Regulations, Sampling.

The high cost of chemical analyses and bioassays of dredged material makes it necessary for decision makers to limit testing to that which will sufficiently characterize the sediment to evaluate a selected disposal alternative. This report offers guidance for limiting the amount of testing necessary and considers other factors that could potentially reduce the cost of testing dredged material. Tiered testing as presented in the Federal Standard is recommended as a cost-reduction approach to material evaluation. The principal advantage of tiered testing is that it can be stopped when sufficient information has been acquired to make a decision regarding the suitability of a given disposal alternative. In developing a sampling plan, consideration should be given to stratified random sampling, compositing, archiving, and use of a risk factor when determining the number of samples needed. All of these considerations, when applied under appropriate circumstances, can result in cost savings. Two factors that could potentially reduce the cost of chemical analysis are careful contract laboratory selection and the use of screening tests and representative analytes. Cost reduction can be achieved in testing dredged material to determine the suitability of a selected disposal alternative by carefully considering the options. The greatest cost reduction will result from the exercise of informed judgment concerning such factors as the significance of site history, the precision and resolution of the sampling design, and the acceptable degree of risk that the sampling will miss contaminated areas. (Lantz-PTT)
W90-08755

SEPTIC TANK SYSTEMS.
National Building Research Inst., Pretoria (South Africa).

For primary bibliographic entry see Field 5D.
W90-08761

DESIGN, PLACEMENT, AND SAMPLING OF GROUNDWATER MONITORING WELLS FOR THE MANAGEMENT OF HAZARDOUS WASTE DISPOSAL FACILITIES.
Argonne National Lab., IL. Energy and Environmental Systems Div.
For primary bibliographic entry see Field 5G.
W90-08773

PHYSICAL AND HYDROLOGICAL PROPERTIES OF MINED SPOILS RECLAIMED BY DIFFERENT AMELIORATION METHODS.
Southern Illinois Univ. at Carbondale. Dept. of Plant and Soil Sciences.
For primary bibliographic entry see Field 2G.
W90-08829

FLOW CYTOMETRIC DETECTION AND SIZING OF FLUORESCENT PARTICLES DEPOSITED AT A SEWAGE OUTFALL SITE.
Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.
For primary bibliographic entry see Field 5A.
W90-08943

TARIFF REDUCTION BY SEGREGATION AND RECYCLING OF A WATER SLUDGE DISCHARGE IN SINGAPORE.
Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering.
For primary bibliographic entry see Field 5F.
W90-08961

FROM OCEAN DISPOSAL TO LANDFILL COVER.
Jacobs Environmental, Parlin, NJ.
A. Jacobs, and M. Silver.
Water Engineering and Management WENMD2, Vol. 137, No. 3, p 28-31, March 1990. 4 fig.

Descriptors: *Sludge disposal, *Sludge filters, *Sludge stabilization, *Sludge treatment, Filters, Landfill covers.

The Middlesex County Utilities Authority, along with five other New Jersey agencies and several New York agencies, is prohibited from dumping sewage sludge in the ocean after December 31, 1991. After evaluating 24 dewatering and subsequent stabilization technologies, the Authority selected dewatering with belt filter presses, followed by chemical stabilization. It was judged the most cost effective, easiest to implement, environmentally sound, beneficial re-use alternative for processing sewage sludge. Several alternatives were pilot tested, including composting, thermal drying/pelletization, and chemical stabilization. The belt filter press technology was the most technically and economically feasible alternative to meet the deadline. Chemical stabilization is a process that converts sewage sludge into a product suitable for landfill cover or for land application. The chemically stabilized sludge has been approved by the New Jersey Department of Environmental Protection for use as daily and intermediate landfill cover, in conjunction with soil, at an Authority-owned landfill near the treatment plant. A demonstration program at the landfill indicated that the physical parameters of the stabilized sludge compared favorably to typical values for soil cover. The results of the demonstration have been used to design the chemical stabilization facility, currently under construction. (Tappert-PTT)
W90-08997

SIMULTANEOUS SLUDGE DRYING AND PELLETIZING.
Bio Gro Systems, Inc., Annapolis, MD.
For primary bibliographic entry see Field 5D.
W90-08998

Group 5E—Ultimate Disposal Of Wastes

WORLD'S LARGEST EGG-SHAPED DIGESTERS.
Crom-RSB, Gainesville, FL.
For primary bibliographic entry see Field 5D.
W90-09001

SLUDGE DISPOSAL USING LIME.
RDP Co., PLymouth Meeting, PA.
For primary bibliographic entry see Field 5D.
W90-09002

NEW APPROACH TO THE DISPOSAL OF SOLID WASTE ON LAND.
J. H. Lehr.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 257-268.

Descriptors: *Groundwater quality, *Land disposal, *Site selection, *Waste disposal, *Water quality management, Aquifers, Environmental protection, Groundwater pollution, Hazardous waste disposal, Hydrogeology, Liners, Monitoring, Public health.

For many decades the U.S. has been actively developing its groundwater assets and, in so doing, uncovered its liabilities. In waste disposal techniques and other human activities that impact groundwater, visible progress and impressive results have occurred on all fronts. Today's waste stream is being dramatically reduced by industry. It is essential that geohydrologists do a better job communicating their knowledge and their optimism to the public; the public must be convinced that groundwater professionals really understand groundwater pollution and are capable of dealing effectively with it. While geohydrologists are involved in efforts to evaluate the pollution potential of differing physical environments, engineers involved in waste disposal are attempting to design 'leak proof' and thus seemingly 'secure' sites. Two aspects of the waste disposal regulations that are especially troubling are those related to liner design for waste disposal pits and site maintenance after closure. The current efforts of geohydrologists to develop site evaluation methods and the efforts of geotechnical engineers to design trouble-free sites are, therefore, obviously of long-range importance. Waste disposal sites must have suitable geohydrologic characteristics, whereby the main defense against movement of pollutants away from the site is the clay cover, for without inflow there will be no outflow. It is accepted that precipitation reaching the waste will result in groundwater pollution; therefore, waste disposal sites should not be located where even minimal groundwater pollution is not acceptable. The ability to monitor simultaneously groundwater and stream pollution is important from both economic and operational standpoints because it reduces the amount of effort that must be devoted to monitoring. It is hoped that this proposal will pique the interest of decision-makers in particular and private citizens in general. (See also W90-09063) (Fish-PTT)
W90-09075

WASTE SITE REMEDIATION TECHNOLOGY.
For primary bibliographic entry see Field 5G.
W90-09077

RECENT ADVANCES IN THE IN SITU MANAGEMENT OF UNCONTROLLED WASTE DISPOSAL SITES.
For primary bibliographic entry see Field 5G.
W90-09079

INFLUENCE OF COMPOSTING AND MATURATION PROCESSES ON THE HEAVY-METAL EXTRACTABILITY FROM SOME ORGANIC WASTES.
Centro de Edafologia y Biologia Aplicada del Segura, Murica (Spain). Dept. of Organic Resources.
C. Garcia, T. Hernandez, and F. Costa.
Biological Wastes BIWAED, Vol. 31, No. 4, p 291-301, 1990. 6 tab, 7 ref.

Descriptors: *Composting, *Fate of pollutants, *Heavy metals, *Municipal wastes, *Organic wastes, *Path of pollutants, *Waste treatment, Cadmium, Chromium, Copper, Iron, Land disposal, Lead, Manganese, Metals, Nickel, Soil amendments, Solid wastes, Zinc.

Seven mixtures from four organic residues (aerobic sewage sludge, city refuse, peat residue, and grape debris) were prepared to study the influence of the composting and maturation processes on the extractability of Fe, Cu Ni, Zn, Cd, Pb, Cr, and Mn by a chelating agent (diethylenetriamine pentaacetic acid, DTPA) and a neutral salt solution (0.05M calcium chloride). Composting occurred over 3 months; maturation for an additional 4 months. Composting and maturation increased the concentration of heavy metals in the materials because of weight loss, which varied from 11.80% to 53.19%, depending on the composition of the residue. The grape debris did not add heavy metals to the mixtures. The composts with aerobic sewage sludge had lower heavy metal contents than composts with city refuse. The composts with peat residues had high Cu contents. The metals became more insoluble with maturation. Extracting materials removed larger amounts of metals from the raw composts than from the mature composts. In general CaCl2-extractable metals did not correlate significantly with the metal content of the composts. With DTPA-extractable metals, the only metals showing correlation between quantity extracted and metal content of the samples were Pb and Zn. The load of zinc equivalent increased with composting and maturation, and the Cd/Zn ratio decreased. (Cassar-PTT)
W90-09184

PHYSICAL CHARACTERIZATION OF A PHYTODEWATERED ANAEROBIC SLUDGE.
Consiglio Nazionale delle Ricerche, Pisa (Italy). Ist. per la Chimica del Terreno.
G. V. Guidi, R. Pini, and A. Scotto.
Biological Wastes BIWAED, Vol. 31, No. 4, p 303-310, 1990. 2 fig, 1 tab, 11 ref.

Descriptors: *Anaerobic digestion, *Sludge drying, Digestion, Plant growth, Soil amendments.

An organic product derived from a new phytodewatering process for anaerobic sludge was characterized to evaluate its possible use as a substrate for growing plants. The patented method is based on the evaporation from the surface of the sludge and the adsorption of water by growing plants (usually maize) over about 90 days. During this time the water content of the sludge drops from about 75% to about 40%. The dry plants are crushed together with the dewatered sludge. Three types of materials were studied: a sandy soil (S), soil + sludge before dewatering (AS), and soil + the product from the phytodewatering process (PS). Total porosities (cu m/cu m) from a graph were 0.4 for S, about 0.5 for S+AS, and about 0.62 for S+PS. Bulk densities showed an inverse relationship, S having the greatest and S+PS having the least. The number of wetting-drying cycles (2 or 5) did not affect the physical parameters. Both sludges added to soil more than doubled the water stability index from 20-30 to about 60. A more complex trend was found for measurements of strength of aggregates. Though aggregates of soil alone broke down with a force higher than that needed for S+PS at the second and fifth cycle, for S+AS this behavior was found only at the fifth cycle, the strength of aggregates at the second cycle from S+AS being higher than that of S. Data on soil surface strength agreed with those of aggregate strength. The force needed to break the surface of S+AS at the second cycle was higher than all others. (Cassar-PTT)
W90-09185

ENVIRONMENTAL IMPACT OF YARD WASTE COMPOSTING.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
For primary bibliographic entry see Field 5B.
W90-09204

FROM TREATMENT PLANT TO FARM FIELDS.
C. Annis.
Biocycle BCYCDK, Vol. 31, No. 4, p 50-51, April 1990.

Descriptors: *Land disposal, *Sludge disposal, *Sludge treatment, *Sludge utilization, Aerobic treatment, Agriculture, Costs, Economic aspects, Nitrogen, Sludge analysis.

Latest national statistics report more than 12,000 cities and communities are land applying wastewater sludge on agricultural lands. In Crossville, TN, a land application program was begun in fall, 1987, using a 2000 gallon tank truck with a spreader bar mounted on the back. Sludge was aerobically treated before being transported and applied to pasture land. Farmers began finding higher crop yields and improved soil from the organic material, and a waiting list was soon created. The percentage of sludge applied to agricultural land steadily increased. Last year, municipal officials studied various sludge disposal methods as the city's population grew and flow to the wastewater treatment facility increased. Evaluation of capital and annual operating costs, plus the positive response of farmers in the previous two years led Crossville officials to decide to continue with land application. The present method compared to alternatives meant a capital savings of approximately $100,000 and an annual operational savings of $20,000. The sludge was analyzed for 126 pollutants and found to be high in nitrogen and phosphorus. There was also a percentage of potassium. All metals were low in comparison to other areas. Since all sludge that is applied to land is treated with hydrated lime, there is little possibility of any toxics or harmful bacteria. All sludge is monitored frequently. At the application rates currently being used, all nitrogen required by the soil is being supplied in the land application program. In a comparison study of commercial nutrients available, and the application rate, each acre is receiving approximately $35 in nutrients. (Chonka-PTT)
W90-09205

ENHANCEMENT OF DRY ANAEROBIC BATCH DIGESTION OF THE ORGANIC FRACTION OF MUNICIPAL SOLID WASTE BY AN AEROBIC PRETREATMENT STEP.
Agricultural Univ., Wageningen (Netherlands). Dept. of Water Pollution Control.
E. ten Brummeler, and I. W. Koster.
Biological Wastes BIWAED, Vol. 31, No. 3, p 199-210, 1990. 7 fig, 1 tab, 16 ref.

Descriptors: *Anaerobic digestion, *Composting, *Municipal wastes, *Sludge digestion, *Solid waste disposal, *Waste disposal, *Waste treatment, *Wastewater treatment, Biogas, Methane, Organic matter, Organic wastes.

The start-up of the dry anaerobic batch digestion by the BIOCEL-concept of the organic fraction of municipal solid waste is unbalanced when a methanogenic inoculum (digested sewage sludge) is added to a total solids concentration of 35%. The unbalanced conditions are the result of the rapid degradation of easily-degradable compounds which are present in the organic fraction. Enhancement of the first start-up of the dry batch digestion was tried by applying an aerobic partial-composting step. By this aerobic treatment the easily degradable compounds are removed. After the composting step the anaerobic digestion will be limited by the conversion of the ligno-cellulose part of the organic fraction. It appeared that at least 19.5% of the volatile solids should be converted during the aerobic composting period before acid formation in the digestion was in balance with the methane formation. This amount of aerobically degraded volatile solids means a 40% loss of potential biogas. The loss of a part of the biogas is a major drawback to the partial composting as a method for enhancing the start-up of the dry anaerobic digestion. A shorter composting

period which is combined with another start-up method might be a feasible method to decrease the energy input of the dry digestion process. (Author's abstract)
W90-09285

ANAEROBIC DIGESTION OF PIG MANURE MIXED WITH SEWAGE SLUDGE.
Hong Kong Baptist Coll., Kowloon. Dept. of Biology.
For primary bibliographic entry see Field 5D.
W90-09287

SAND-BENTONITE LINERS: PREDICTING PERMEABILITY FROM LABORATORY TESTS.
Ecole Polytechnique, Montreal (Quebec).
R. P. Chapuis.
Canadian Geotechnical Journal CGJOAH, Vol. 27, No. 1, p 47-57, February 1990. 13 fig, 2 tab, 24 ref. Natural Sciences and Engineering Research Council of Canada Grant U-0502.

Descriptors: *Bentonite, *Landfill linings, *Liners, *Materials testing, *Permeability, *Waste disposal, *Wastewater disposal, Hydraulic conductivity, Porosity, Quebec, Sand, Sand-bentonite liners, Soil physical properties, Waste dumps.

Horizontal or sloping barriers called liners may be artificial (geomembranes) or natural, like compacted clays, silty soils, mine tailings, and soil-bentonite mixes. This paper deals with soil-bentonite mixes used as liners to contain waste or wastewater; in recent years many municipal wastewater ponds have been built with such liners in the Province of Quebec. Numerous results of laboratory permeability tests are presented for soil-bentonite mixtures used as impervious liners. The hydraulic conductivity is shown to be poorly correlated to porosity alone, bentonite content alone, or total fines content alone. The laboratory test results seem difficult to analyze because different testing methods have been used in which it is not easy to control certain parameters, such as hydration period, degree of saturation, and swelling under low confining pressure. The hydraulic conductivity (k), however, is shown to be correlated to an 'efficient' porosity (n) which corresponds to the pore space available for seepage of the fast-moving water. When n is negative, it means that all water seeps through hydrated bentonite. The field values of n and k may be predicted using the results of a modified Proctor test and a permeameter test performed on the sand alone, and the bentonite content. Two methods are proposed: they predict k values usually within one order of magnitude of the values given by laboratory tests performed on mixes having a degree of saturation higher than 90%. The two methods may be used to select a soil and roughly estimate the bentonite content to achieve the required imperviousness of the mix. After this preliminary estimation and a cost analysis, laboratory permeability tests must be performed under strictly controlled conditions so as to avoid a major underestimation of the hydraulic conductivity. Then the global field performance of the liner may be predicted by taking into account the laboratory results and layer thickness. The total leakage is predicted with resulting global k value that is higher than that corresponding to the average bentonite content as given by laboratory tests with homogeneous mixes. (Author's abstract)
W90-09307

MONITORING WELL INTO ABANDONED DEEP-WELL DISPOSAL FORMATIONS AT SARNIA, ONTARIO.
INTERA Technologies Ltd., Ottawa (Ontario).
K. G. Raven, D. W. Lafleur, and R. A. Sweezey.
Canadian Geotechnical Journal CGJOAH, Vol. 27, No. 1, p 105-118, February 1990. 12 fig, 3 tab, 31 ref.

Descriptors: *Disposal wells, *Groundwater contamination, *Monitoring wells, *Ontario, *Path of pollutants, *Underground waste disposal, *Waste disposal, Geological formations, Hydraulic conductivity, Industrial wastes, Injection wells, Permeability, Phenols, St Clair River.

A 300 m deep monitoring well was completed to the Detroit River Group of formations in Sarnia, Ontario, to evaluate the potential near-surface impacts resulting from previous deep injection of industrial waste. Detailed logging, testing, and sampling were performed to evaluate the vertical distribution of industrial waste and to determine hydraulic conductivity and hydraulic head in the disposal horizon and in the confining formations. Results of hydraulic testing indicate the hydraulic conductivity of the disposal formation is 2 to 200 nm/s and that of most of the confining shale and limestone formations is less than 0.1 nm/s. Analyses of groundwater samples and results from other studies show that industrial waste, characterized by elevated phenol concentrations, is present in a 10 m horizon in the Lucas dolomite disposal formation at 192 m depth. Waste is also likely present within 2-3 m thick, high-permeability limestone layers at 74 and 123 m depth in the confining units of the Hamilton Group. Because of the generally low vertical hydraulic conductivity of the confining formations, waste in the permeable limestone layers was likely introduced via poorly constructed disposal wells, cavern storage wells, or abandoned oil and gas wells. The hydraulic conductivity and hydraulic head data indicate the high pressures resulting from injection into the disposal formation have dissipated. The head within the zone of residual contamination in the disposal formation is now 8 m below the level of the St. Clair River. The hydraulic data and chemical composition of the injected waste show that the discharges of tarry liquids on the bottom of the St Clair River in 1984 and 1985 were not caused by upward migration of injected waste. (Author's abstract)
W90-09308

BACTERIAL MUTAGENICITY OF LEACHATE WATER FROM MUNICIPAL SEWAGE SLUDGE-AMENDED SOILS.
Texas A and M Univ., College Station. Dept. of Soil and Crop Sciences.
For primary bibliographic entry see Field 5C.
W90-09335

METALS CONTROL TECHNOLOGY: PAST, PRESENT AND FUTURE.
Illinois Inst. of Tech., Chicago.
For primary bibliographic entry see Field 5D.
W90-09383

CHEMICAL EQUILIBRIUM ANALYSIS OF LEAD AND BERYLLIUM SPECIATION IN HAZARDOUS WASTE INCINERATORS.
Kansas State Univ., Manhattan.
For primary bibliographic entry see Field 7B.
W90-09385

CHEMICAL SPECIATION OF HEAVY METALS IN SOILS FOLLOWING LAND APPLICATION OF CONDITIONED BIOLOGICAL SLUDGES AND RAW PIG MANURE.
Pavia Univ. (Italy). Dept. of Hydraulic and Environmental Engineering.
M. Baldi, M. C. Negri, and A. G. Capodaglio.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 377-392, 8 fig, 4 tab, 16 ref.

Descriptors: *Chemical speciation, *Copper, *Fate of pollutants, *Heavy metals, *Land disposal, *Nickel, *Path of pollutants, *Urban hydrology, *Waste disposal, *Zinc, Farm wastes, Manure, Wastewater irrigation.

The utilization of biological sludge from civil and industrial wastewater treatment processes as organic soil conditioners is now a common disposal practice in several countries, as traditional sludge management practices are replaced by resource recovery and conservation alternatives. Fertirrigation is also rapidly becoming a widely accepted and adopted method of disposal for untreated organic wastewaters. Raw pig manure is often disposed of in this way because it contains high

quantities of macronutrients, and in particular nitrogen, necessary for crops. In this study the fate of some heavy metals introduced into the soil matrix by the addition of sludges and raw manure is investigated. Three different extraction schemes were adopted. In each extraction, a solid/liquid ratio of 1:20 was maintained. An aliquot of 2.50 g of soil in 50 cc of bidistilled water was centrifuged and the solid phases were treated with 50 cc of 1 M KNO3 solution for the first and second series, and 1 M BaCl2 solution for the third one. Although the three separation techniques were comparable, the BaCl2 solution was more effective than the 1 M KN)3 solution. Apart from this consideration, all the analytical procedures lead to analogous final considerations. The three heavy metals (Cu, Ni, Zn) considered in this study dissociate into the various chemical species depending on their chemical nature, and independently from sludge or raw manure soil treatments. The intrinsic metal concentration variance from the untreated parcels samples is often comparable with that observed in the remainder of the treated samples. After a whole year of treatment, not only was there no increase in the total quantity of metals in the agricultural soil layer, but even the most easily metabolized species did not show any significant differences. (See also W90-09381) (Lantz-PTT)
W90-09397

CHEMICAL DECONTAMINATION OF DREDGED MATERIALS, SLUDGES, COMBUSTION RESIDUES, SOILS AND OTHER MATERIALS CONTAMINATED WITH HEAVY METALS.
Heidelberg Univ. (Germany, F.R.). Inst. fuer Sedimentforschung.
For primary bibliographic entry see Field 5D.
W90-09402

DISPOSAL OF DILUTE AND CONCENTRATED AGRICULTURAL PESTICIDES USING ABSORPTION AND CHEMICAL AND MICROBIAL DEGRADATION.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5D.
W90-09459

RUNOFF LOSSES OF TWO TRIAZINE HERBICIDES AND METACHLOR FROM CONVENTIONAL AND NO-TILL PLOTS AS INFLUENCED BY SLUDGE.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Plant Pathology, Physiology and Weed Science.
For primary bibliographic entry see Field 5B.
W90-09468

RESULTS OF ON-GOING MONITORING OF THE PERFORMANCE OF A LOW PERMEABILITY CLAY LINER, KEELE VALLEY LANDFILL, MAPI E ONTARIO.
Golder Associates, Mississauga (Ontario).
For primary bibliographic entry see Field 5B.
W90-09486

PRESERVING WATER QUALITY WITHOUT SEWERS: A CASE STUDY OF ON-SITE WASTEWATER DISPOSAL HYDROGEOLOGY.
Shevenell Gallen and Associates, Inc., Portsmouth, NH.
For primary bibliographic entry see Field 5G.
W90-09487

HYDROGEOLOGIC CONSIDERATIONS IN THE DESIGN AND OPERATION OF A PCB WASTE CONTAINMENT FACILITY IN LONDON, ONTARIO.
Conestoga-Rovers and Associates, Waterloo (Ontario).
J. M. Petrie, and A. J. Crutcher.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National

Group 5E—Ultimate Disposal Of Wastes

Water Well Association, Dublin, Ohio. 1989. p 109-121, 5 fig.

Descriptors: *Geohydrology, *Groundwater movement, *Hazardous waste disposal, *Polychlorinated biphenyls, *Waste disposal, *Water pollution control, Groundwater level, Hydraulic gradient, Leachates, Permeability, Water table.

As part of the cleanup of PCB contaminated soils in Pottersburg Creek in London, Ontario, it was necessary to establish secure hazardous waste containment facilities. Four double clay lined facilities designed to maintain an inward hydraulic gradient were constructed. This site is underlain by 20 m of generally low permeable heterogeneous tills of which the upper 4 m are weathered and fractured. A hydraulic gradient of -0.65 is directed downward to the underlying sand and gravel. The water table fluctuates seasonally over a 1.5 m range and at the end of the summer typically lies 2-3 m below ground level. This double liner system comprises a Leak Detection System (LDS) consisting of a 0.3 m thick sand blanket sandwiched between upper and lower recompacted clay liners, lying at an elevation some 2 m below the low water table elevation. The fluid level in the LDS is controlled by pumping, to ensure that groundwater flow is directed inwards. In addition, a downward gradient is maintained across the upper liner from the overlying leachate collection system (LCS). The double lined construction, taking advantage of inward hydraulic gradients, provides secure containment of the encapsulated PCB contaminated soils. (See also W90-09479) (Author's abstract)
W90-09488

RISK BASED DECISION MAKING PROCESS FOR THE SELECTION OF SANITARY LAND-FILLS: 'THE POLITICAL REALTY'.
Trow, Dames and Moore, Mississauga (Ontario). Waste Management and Environment Div.
For primary bibliographic entry see Field 6A.
W90-09489

NITRATE LOADING METHODOLOGIES FOR SEPTIC SYSTEM PERFORMANCE PREDICTION: STATE OF AN ART.
Gerber (Robert G.), Inc., Freeport, ME.
For primary bibliographic entry see Field 5G.
W90-09492

5F. Water Treatment and Quality Alteration

DESTRUCTION OF PESTICIDES AND THEIR FORMULATIONS IN WATER USING SHORT WAVELENGTH UV LIGHT.
California Univ., Davis. Dept. of Environmental Toxicology.
D. Peterson, D. Watson, and W. Winterlin.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 5, p 744-750, May 1990. 10 ref. California Dept. of Health Services Contract 86-T0023.

Descriptors: *Degradation, *Pesticides, *Photolysis, *Ultraviolet radiation, *Water pollution treatment, *Water treatment, Benzenes, Captan, Chlordane, Fate of pollutants, Groundwater pollution, Opacity, Pesticide kinetics, Xylenes.

Decontamination of water polluted with toxic chemicals poses economic and logistical challenges since the pollutants are usually present in low concentrations and distributed over a wide area. A number of strategies, including those involving photochemical processes, have been proposed and tested to destroy toxic materials in water. In this study, a photoreactor equipped with a high pressure mercury vapor lamp was evaluated for the destruction of three pesticides and the inert ingredient m-xylene in water. Captan, chlordane, pentachloro nitrobenzene (PCNB), and m-xylene were selected as model compounds for this study based on their use, resistance to UV degradation, and potential presence in formulated pesticide materials. In experiments with UV light and 115 ppm hydrogen peroxide, m-xylene had an average half

life of 4.0 minutes, from initial concentrations of 36.1 ppm and 56.7 ppm. With or without the presence of hydrogen peroxide or carrier solvent, 1 ppm captan was found to be degraded with a half life of 1.4 minutes. PCNB, rapidly degraded in optically clear water by UV light with or without hydrogen peroxide, had an average half life of 2.6 minutes at initial concentrations ranging from 0.09 to 2.4 ppm. Hydrogen peroxide also had no effect on the rate of chlordane breakdown. Chlordane was destroyed following first order kinetics with a half life of 3.9 minutes. Although the system used in this study rapidly degraded m-xylene and the three pesticides in optically clear water, the optical clarity of the wastewater is critical to the success of the pesticide breakdown. Using a 1000 ppm solution of PCNB created as a 0.2% emulsifiable concentrate formulation, there was no detectable destruction. The Perox Pure Model SQ-5 photoreactor used is most suited for the treatment of dilute pesticides in groundwater or surface runoff water, not for high concentrations of hazardous materials. (VerNooy-PTT)
W90-08656

DEFLUORIDATION OF WATER BY ADSORPTION ON FLY ASH.
Banaras Hindu Univ., Varanasi (India). Dept. of Applied Chemistry.
For primary bibliographic entry see Field 5D.
W90-08687

COMPUTER APPLICATIONS IN WATER SUPPLY. VOLUME 1: SYSTEMS ANALYSIS AND SIMULATION.
John Wiley and Sons, Inc., New York, New York. 1988. 445 p. Edited by Bryan Coulbeck and Chun-Hou Orr.

Descriptors: *Algorithms, *Computer models, *Computer programs, *Computer-aided design, *Computers, *Mathematical models, *Model studies, *Water conveyance, Control systems, Mathematical analysis, Mathematical equations, Water supply, Water supply development, Water users.

The specific and unique features of water supply and distribution systems and the complexities of the modeling and control tasks have been the subject of research attention over a number of years. Efficient algorithmic procedures and techniques have evolved for analysis, design and optimized control purposes. The water industry appears to be committed to the development of user friendly computer programs incorporating these latest research results. This text consists of the edited proceedings of the International Conference on Computer Applications for Water Supply and Distribution, held September 8-10, 1987 at Leicester Polytechnic, England. The subject matter includes descriptions of associated algorithms and computer program implementations together with current practice in applications of the work to real systems. Specific requirements and general overviews are presented for management, engineering, operations, computing and research. Volume I covers computer-based techniques for data collection, engineering analysis, mathematical modeling and operational simulation of water supply and distribution systems. (See W90-08777 thru W90-08799) (Mertz-PTT)
W90-08776

GRADIENT ALGORITHM FOR THE ANALYSIS OF PIPE NETWORKS.
Bologna Univ. (Italy). Ist. di Costruzioni Idrauliche.
E. Todini, and S. Pilati.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 1-20. 18 ref.

Descriptors: *Algorithms, *Computer models, *Mathematical equations, *Network analysis, *Water conveyance, Computer analysis, Computers, Flow augmentation, Incomplete Choleski Factorization/Modifi, Model studies, Newton-Raphson technique, Pipe flow.

In order to find the solution of the system of partly linear and partly nonlinear equations describing the network flow problem, the Newton-Raphson technique given both unknown pipe flows and unknown nodal heads, can lead to an extremely convergent scheme. The derivation of a gradient algorithm can be used for flow analysis in pipe networks. The Newton-Raphson technique was applied both in terms of nodal heads and pipe flows to the simultaneous solution of the system of partly linear and partly nonlinear equations expressing mass and energy balance. The problem was analytically reconducted to the interactive solution of a system of linear equations, which size equals the number of unknown heads. The solution was then efficiently obtained using the Incomplete Choleski Factorization/Modified Conjugate Gradient algorithm. The convergence properties of this or similar schemes, combined to the limited number of operations required make this scheme particularly useful for the solution of large and complex networks on small machines, such as personal computers. (See also W90-08776) (Mertz-PTT)
W90-08777

COMPARISON OF COLEBROOK-WHITE AND HAZEN-WILLIAMS FLOW MODELS IN REAL-TIME WATER NETWORK SIMULATION.
Durham Univ. (England). School of Engineering and Applied Science.
A. Usman, R. S. Powell, and M. J. H. Sterling.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 21-37. 3 fig, 6 tab, 12 ref.

Descriptors: *Computer models, *Flow models, *Network analysis, *Pipe flow, *Water conveyance, Colbrook-White model, Comparison studies, Computers, Hazen-Williams model, Model studies, Network design, Newton-Raphson technique, Viscosity, Water temperature.

The implications of modeling large water distribution networks using the Colebrook-White and Hazen-Williams representations as the basis of the dynamic real-time simulator were investigated. In both cases, the Newton-Raphson iterative procedure was used. The Colebrook-White flow model proved very cumbersome compared to the Hazen-Williams flow coefficient, but the Hazen-Williams suffered a drawback in that it was not very accurate under varying flow conditions. The Hazen-Williams flow model did not incorporate a dependance on water temperature and, therefore, was not a reliable model for varying flow conditions that occurred from one season to another. On the other hand, the Colebrook-White flow model explicitly depended on water viscosity, which is a function of water temperature. Hence, using the Colbrook-White flow model, the average water temperature could be altered or selected on-line, thus making the model very attractive for real-time dynamic simulation for varying flow conditions. It was concluded that the Colebrook-White representation was better suited to real-time computation of wide ranging flow conditions and could be incorporated with acceptable accuracy and computation time. (See also W90-08776) (Mertz-PTT)
W90-08778

COMPARISON OF THE GRADIENT METHOD WITH SOME TRADITIONAL METHODS FOR THE ANALYSIS OF WATER SUPPLY DISTRIBUTION NETWORKS.
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
R. Salgado, E. Todini, and P. E. O'Connell.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 38-62. 4 fig, 1 tab, 28 ref, append.

Descriptors: *Algorithms, *Computer models, *Network analysis, *Water conveyance, *Water distribution, Comparison studies, Computer analysis, Computers, Hydraulic gradient, Model studies, Optimization, Pipe flow, Water supply.

A gradient algorithm for the analysis of water supply distribution networks was compared with other traditional gradient algorithms (simultaneous path and linear theory). The algorithm showed robust behavior when run with some examples simulating different operational situations, while the most reliable traditional methods demonstrated a variety of problems. The proposed gradient method could directly solve looped and partly branched networks, while the simultaneous path method required transformation into an equivalent looped network prior to the application of the iterative algorithm. The proposed gradient method did not need a loop or path definition, as did the simultaneous path adjustment and the linear theory methods. The proposed gradient method could also solve in a straightforward way networks that may become disjointed during certain periods of operation. Additionally, the proposed method can be implemented on a personal computer, given its low requirement of memory and its high speed. The proposed method can be applied for design and operation optimization purposes, since its fast and reliable convergence properties make it preferable to the traditional methods. An extended version of the method, able to cope with unsteady flow, is currently under development. (See also W90-08776) (Mertz-PTT)
W90-08779

NETWORK ANALYSIS--THE REAL STORY.
WRc Engineering, Swindon (England).
R. Allen.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 63-80. 5 fig, 3 tab.

Descriptors: *Computer models, *Mathematical models, *Model studies, *Network analysis, *Pipe flow, *Water conveyance, *Water distribution, Calibration, Comprehensive planning, Computer analysis, Computers, Model testing, Project planning.

A computer model of a water distribution system is a set of equations that calculates the pressures and flows in that system. Results from the model are only as accurate as the data with which they are determined. The planning and practical aspects of model production are equally as important as its calibration and utilization. The three main stages of network analysis are Planning, Performance and Practice. The calibration stage of preparing a network model follows a great deal of preparatory work and planning for which experience is essential. Setting the objectives and performance standards for the model following discussions with end users, distribution staff and network analysis experts is a priority with should be undertaken at the earliest opportunity. The planning and performance of an adequately detailed field test is another important step and mistakes of omissions at this stage can be costly, both financially and operationally. At all stages during the study, close interaction between distribution system staff and the study team is essential. Of the three stages--planning, performance and practice--none is more intrinsically valuable than the planning stage which sets the objectives, scope and detail of the model and defines its final accuracy and applicability. (See also W90-08776) (Mertz-PTT)
W90-08780

SOME DYNAMIC DEMAND ASPECTS OF NETWORK ANALYSIS MODELLING.
Ward, Ashcroft and Parkman, Chester (England).
G. J. Cleverly, and W. G. Wright.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 81-103. 9 fig, 9 tab, 2 ref.

Descriptors: *Computer programs, *Data acquisition, *Network analysis, *Water demand, *Water use, Computer analysis, Computers, Data interpretation, England, GINAS program, Model studies, WATNET program, Water conveyance, Water metering.

Data collection constitutes a major component of network analysis and a balance must be achieved

between precision and cost if the exercise is to be worthwhile. The characteristics of each major component of demand, including the diurnal variation in demand, can be determined from a combination of accurate field measurements, billing records and known or assumed consumption characteristics. Inaccuracies will exist, however, and some judgement is required if the sophisticated facilities available on the GINAS and WATNET programs considered are to be fully exploited. The use of demand allocation areas based on postal codes is considered advantageous. The allocation of the leakage component of demand is described for the rural Yorkshire Water and North West Water, England systems. The adoption of 10 hour and 16 hour metered demand profiles with nighttime usage at 50% of the average usage is advocated. A peak factor of 2.5 for total demand is only considered appropriate to small supply areas (typically less than 1000 properties). Standard demand profiles can be established for most categories of metered consumers. Other categories of metered consumers with a less predictable characteristic (for example, horitcultural users) must be individually measured wherever they represent a significant demand on the system. (See also W90-08776) (Mertz-PTT)
W90-08781

NETWORK ANALYSIS: A USER'S VIEWPOINT.
Haiste Ltd., Leeds (England).
J. Suter, and C. D. Newsome.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 104-126. 4 fig, 3 tab, 4 ref.

Descriptors: *Computer models, *Data acquisition, *Metropolitan water management, *Network analysis, *Optimization, *Water conveyance, *Water distribution, *Water management, Computer analysis, England, Management planning, Model studies, Performance evaluation, Pipe flow, Telemetry.

In recent years the need for more advanced techniques for the operational management of water distribution systems has been clearly identified. To meet these needs Yorkshire Water Western Division devised an integrated program of Network Management revolving around a 4 year program of network analysis which commenced in 1985/1986. The principal elements of Network Management, which includes leakage control, pressure control, network reinforcements and telemetry are: (1) The establishment and implementation of data acquisition systems; (2) The implementation of comprehensive asset records and a performance register; and (3) The utilization of these systems to optimize network performance. The models are currently proving invaluable in the design of district metering and pressure reduction schemes which are being implemented under the network management program. The models are also finding extensive use in the design of new works and in the investigation of operational problems. The program has identified the need for additional work on the derivation of demand profiles and in the performance of existing monitoring equipment, although the equipment trials currently being undertaken have yielded encouraging preliminary results. (See also W90-08776) (Mertz-PTT)
W90-08782

OPERATIONAL EXPERIENCE OF GINAS AND WATNET.
Ward, Ashcroft and Parkman, Chester (England).
W. G. Wright, and G. J. Cleverly.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 127-154. 6 fig, 6 tab, 3 ref.

Descriptors: *Computer models, *Computer programs, *GINAS program, *Network analysis, *WATNET program, *Water conveyance, *Water distribution, Comparison studies, Computer analysis, England, Metropolitan water management, MicroWATNET model, Model studies, Model testing, Rural areas, Water demand, Water management.

In an effort to develop a computer model for the trunk mains network in the Hull City Distribution Zone, England, four case studies (three urban and one rural) were examined using either the WATNET, MicroWATNET or GINAS programs. Network analysis studies showed that accurate network models were capable of being produced using all three of the programs. MicroWATNET, while not as powerful at the other programs, did not rely on a mainframe computer, so had the advantage of being portable. The graphics of WATNET proved most useful. MicroWATNET and GINAS were both limited by the number of nodes they were capable of modeling. The 50 time steps available on GINAS prevented a full 24 hour analysis during one simulation, although the program allowed incorporation of a greater number of demand types and was the only program that allowed modeling of pressure switches. When models were divided into subareas, the curved head reservoir facility on GINAS was very useful. When comparing rural and urban studies, it was found that rural studies typically had more dynamic features and were more sensitive to variations in large consumers' demands. Rural models were also more sensitive to small changes in diameter or roughness value or extended lengths of mains and leakage levels were more difficult to determine and allocate. Virtually all rural mains required modeling, irrespective of size and rural studies were more sensitive to seasonal changes in metered demand, especially horticultural demands. (See also W90-08776) (Mertz-PTT)
W90-08783

LONDON'S WATER SUPPLY IN THE 21ST CENTURY--COMPUTER MODELLING ASPECTS.
Thames Water Authority, Reading (England). Planning Dept.
M. Keane, R. Harrison, and N. Britton.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 155-174. 9 fig, 1 ref.

Descriptors: *Computer models, *England, *London, *Model studies, *Network analysis, *Network design, *Water conveyance, *Water demand, *Water distribution, *Water supply, Computer analysis, Computer programs, Cost analysis, Optimization, Pipe flow, Tunnel construction, WATNET program, Water supply development.

Faced with a continuing growth in demand and the need to replace a large part of London's aging water supply system, Thames Water has devised an integrated strategy for future water supply to the Capital. At the core of this strategy is the construction of over 60 km of deep tunnel (the London Water Ring Main) to convey water to the Captial's major demand centers. The Ring Main will supply some 1,300 million L/day of treated water which is equivalent to 50% of London's current average daily supplies. An optimum flow rate of 1.25 m/s has been assumed for the purpose of design calculations to keep friction losses to a minimum. Several route options were simulated and the results indicated that these had little effect upon the hydraulic gradient to the demand centers. Results obtained from the WATNET analysis were thought sufficient to provide a comparison of the route options, based on pumping costs. In early 1986, Leicester Polytechnic was commissioned to produce a model of the projected Ring Main and the primary trunk distribution system, including service reservoirs and existing pumps utilizing the GINAS suite of programs. As construction of the model progressed, it was apparent that the performance of the individual zones was not as independent as had initially been thought. When completed the final model will include 60 distribution zones, 25 service reservoirs, 11 Ring Main pumpout shafts, 10 surface high lift pumping stations, and 5 treatment works. In March 1986, the Secretary of State for the Environment turned the first sod on the Stoke Newington shaft, signalling the commencement of work on the London Water Ring Main project. (See also W90-08776) (Mertz-PTT)

W90-08784

SYSTEMS APPROACH TO EXTENDED GINAS APPLICATIONS.

Leicester Polytechnic (England). Water Control Unit.
C. H. Orr, and B. Coulbeck.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 175-195. 6 fig, 10 ref.

Descriptors: *Computer programs, *Cost analysis, *GINAS program, *Network analysis, *Simulation analysis, *Systems analysis, *Water conveyance, *Water demand, *Water distribution, Computer analysis, Computer models, Computers, Control systems, Data analysis, Hydraulic models, Model studies, Pipe flow, Telemetry.

GINAS (Graphical Interactive Network Analysis and Simulation) is a computer program that provides comprehensive network analysis and simulation facilities for water distribution systems. The program includes hydraulic simulation, as well as cost computation. The system hydraulic option can be used for both static and dynamic simulations. Cost computation can be applied to all available pump and supply sources to provide operating costs for defined control strategy. Together, these hydraulic cost computations provide a powerful facility for system analysis, engineering design, and operational control. An External Data Entry facility allows operational data to be directly input from selected external processes. Upon completion of the corresponding GINAS computation, simulated results are returned to the external process via an External Results Output facility. This data exchange capability allows GINAS to be connected to a range of external systems, such as telemetry linked on-line simulation, closed-loop system control, etc. The outlined interface capability permits a systems approach towards full integration with operational control schemes that can be valuable in the overall management of water supply systems. (See also W90-08776) (Mertz-PTT)
W90-08785

USE OF SIMULATION MODELS OF WATER SUPPLY SYSTEMS--PROCESSING OF INPUT AND OUTPUT DATA.

Laboratorio Nacional de Engenharia Civil, Lisbon (Portugal).
H. Alegre, and S. Teixeira Coelho.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 196-218. 5 fig, 11 ref, append.

Descriptors: *Computer models, *Computer programs, *Data requirements, *Model studies, *Network analysis, *Simulation analysis, *Water conveyance, Computer analysis, Computers, Data analysis, Data interpretation, Data quality control, Hardy-Cross method, SILOCA program, SIMAI program, SIMAL program, SIMAV program, SIPREDA program, Water demand, Water management, Water supply.

Simulation models of water supply systems have been used at the Laboratorio Nacional de Engenharia Civil for some years. Water supply systems design and simulation models become far more attractive and easy-to-use tools for supporting decision-makers if data preparation and modification is simple and rapid and outputs are easy to interpret. Therefore, processing of input and output data of water supply and distribution models have deserved a special attention in Laboratorio Nacional de Engenharia Civil's research activity in the field of water supply. Appropriate software is to be connected to a relational data base and included in an experimental Decision-Support-System to be designed for off-line management of the water supply and distribution systems of the Almada Municipality. The first computer program developed to solve the hydraulic equilibrium of a water supply network was devised in the early 1960s. The program was written in ALGOL and used the Hardy-Cross method to solve loop equations. Preparation on input data was very tedious

and had little practical use. Since then, SIMAL1, SIMAL2 and SIMAL3 programs have been used. SIMAV was used to detect the most frequent mistakes committed when preparing input data for SIMAL1. SILOCA is a very simple program that allowed for considerable time-savings. Two other programs concerned with network loading were later developed--SIMAI and SIPREDA. (See also W90-08776) (Mertz-PTT)
W90-08786

APPLICATIONS OF MICROCOMPUTERS IN THE DESIGN AND OPTIMISATION OF WATER SUPPLY AND DISTRIBUTION SYSTEMS IN DEVELOPING COUNTRIES.

City Univ., London (England). Thermo-Fluids Engineering Research Center.
A. R. D. Thorley, and D. J. Wood.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 219-245. 7 fig, 7 tab, 8 ref.

Descriptors: *Computer analysis, *Computer models, *Cost analysis, *Developing countries, *Microcomputers, *Network design, *Optimization, *Water conveyance, *Water distribution, *Water supply, Management planning, Model studies, Pipe flow, Project planning, Pumps, Reservoirs, Water demand, Water loss.

Microcomputers are providing engineers, designers, and managers with considerably improved methods for the design, optimization, and operation of water supply and distribution systems. Any hydraulic analysis model should allow consideration of general network configurations with no restrictions on the location of pumps, reservoirs, and similar storage arrangements, as well as accommodating various other hydraulic components. To achieve this each pipe section should be capable of including pumps, various valves and fittings that cause concentrated energy losses, and connections to constant pressure supplies or discharges. The use of slightly less sophisticated models, capable of being run on microcomputers, can help contain the expense of preliminary studies. Basic assumptions that must be made when using a personal computer include: a preliminary project scheme has been formulated; construction cost and other project cost items relevant to the system have been estimated; operation and maintenance costs of the system during the first year have been estimated; the project is to be financed solely from a loan for the full cost; only the first three years on operation are considered; and measures of financial feasibility are based on design, construction, and operating costs. Water demand projections include the domestic, commercial and industrial demands and also include provision for unaccounted water such as leakage losses. Total project cost is the sum of the costs of construction, including land, engineering, legal costs and capitalized interest. (See also W90-08776) (Mertz-PTT)
W90-08787

WATER SUPPLY APPLICATIONS PROGRAMS IN AN OPERATIONS ENVIRONMENT.

Leicester Polytechnic (England). Water Control Unit.
C. H. Orr, B. Coulbeck, and M. Brdys.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 246-267. 11 fig, 10 ref.

Descriptors: *Computer programs, *Operating policies, *Pumps, *Water conveyance, *Water supply, Computer analysis, Computer models, Computers, England, GIDAP program, GIMPOS program, GINAS program, GINED program, GIPOS program, Model studies, Simulation.

A suite of computer applications programs, developed within the Water Control Unit, for analysis, design, simulation, and control of water supply and distribution systems was examined. Independent operations of GIPADS, GINAS, GINED, GIPOS/GIMPOS, and GIDAP were reviewed. These programs are intended for use in both engi-

neering and operational situations and are presently used by a number of United Kingdom water authorities and engineering consultants. Although designed as individual modules, the programs are functionally related and can be used in conjunction with each other to form integrated environment for on-line control schemes. The proper environment for operational control should contain various tools for evaluation, and implementation of on-line control schemes. The controller is an essential element of the overall scheme. A successful implementation requires a thorough understanding of the system behavior and a comprehensive evaluation of the system performance under any control policy. A simulation facility can be used to carry out these tasks. The availability of a simulation tool can also aid in general system designs as well as in daily operations. Pumps are usually the main control elements. Their hydraulic and power characteristics should be analyzed fully and modeled accordingly. (See also W90-08776) (Mertz-PTT)
W90-08788

TIME SERIES MODELLING OF WATER DEMAND--A STUDY ON SHORT-TERM AND LONG-TERM PREDICTIONS.

Instituto de Ingenieria Cibernetica, Barcelona (Spain).
J. Quevedo, G. Cenbrano, A. Valls, and J. Serra.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 268-288. 7 fig, 4 tab, 13 ref.

Descriptors: *ARIMA model, *Computer models, *Metropolitan water management, *Model studies, *Spain, *Time series analysis, *Water conveyance, *Water demand, Computer analysis, Estimating, Forecasting, Water distribution.

One of the main problems affecting the management of water distribution systems is the forecasting of consumer demands ahead of time. It is particularly important that short-term (24-hour) forecasts of water demand be accurately estimated in order that minimum-cost pumping schedules may be computed. The development of water demand models in urban water distribution systems through time series analysis was considered. The use of ARIMA (auto-regressive, integrated, moving average) models containing, in some cases, periodic deterministic components was studied for daily and monthly demand predictions in the distribution networks of Barcelona, Spain. For several months, a program for on-line forecasting was implemented in the centralized command system of Barcelona to validate the model. Though the predictions were initially good, as soon as a large deviation of demand from the predicted value occurred, the situation deteriorated. A periodic seven-day pattern was observed in the prediction errors, which showed a non-decreasing sequence of error in successive seven-day periods after an abnormally large prediction error. In the stochastic model, a seasonal 12-month pattern with no apparent changes in the variance values between different periods was observed. The mean value tended, however, to increase from one period to the other, a fact which suggested non-stationarity of the series confirmed by the study of the autocorrelation functions. Hourly forecasts were derived from daily predictions through the use of average load allocation curves. (See also W90-08776) (Mertz-PTT)
W90-08789

APPLICATIONS OF TIME SERIES ANALYSIS TO WATER DEMAND PREDICTION.

Tongji Univ., Shanghai (China). Dept. of Environmental Engineering.
Y. C. Chen.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 289-296. 3 fig, 2 tab, 3 ref.

Descriptors: *Computer models, *Forecasting, *Time series analysis, *Water demand, ARIMA model, Computer analysis, Management planning,

Model studies, Prediction, Statistical analysis, Water conveyance, Water supply.

A prerequisite for on-line control of water supply distribution systems is the short-term prediction of water demands. Time series analysis was employed in this study for the modeling and predicting of hourly water demands. For the purpose of on-line control of a water supply distribution system, it was necessary to obtain one-step ahead prediction, on a short-term basis of hourly or daily demands. In this study, it was found that the water demand could be expressed using the difference equation known as an ARIMA model. The time series of hourly demand was obtained from two methods: one was formed by considering each following hour of the same day, another was formed by considering the same hour for each following day. Time series analysis proved suitable for the modelling and short-term predicting of water demands. Higher predicting precision could be obtained by combining the two methods for predicting hourly demands. The results imply that the methods are applicable to long-term prediction, giving an adequate data base for the purpose of designing and planning water supply systems. (See also W90-08790) (Mertz-PTT)
W90-08790

AUTOMATED METHOD FOR PROCESSING CONSUMER DEMAND INFORMATION WITH REFERENCE TO WATER DISTRIBUTION SYSTEM MODELLING--THE DEVELOPMENT OF A DEMAND ALLOCATION AND MAPPING PACKAGE (DAMP).
Severn-Trent Water Authority (England).
A. Elton, and L. F. Brammer.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 297-316. 3 fig, 8 ref.

Descriptors: *Automation, *Computer models, *Data acquisition, *Data analysis, *England, *Model studies, *Water allocation, *Water demand, *Water distribution, Computer analysis, Computers, Metropolitan water management, Network analysis, Simulation, Water metering.

Computer simulation of water distribution networks is now a widely accepted tool in the water industry. The success with which network simulation models can be created and applied depends very much on the accuracy of their demand data. The manual assessment of water demand has proved to be a time consuming and laborious process. An automated method for assessing network demands from computerized consumer billing information in the Severn-Trent Water Authority, England, was developed and implemented. There were several potential areas of development that may be applied to the computerized process which would improve accuracy, scope and applicability: billing records are being updated and further postcoded, consumer meters are more regularly maintained, and a more precise method of map referencing postcoded areas is being developed by the Post Office. Also, attempts to determine the relationships between consumer type and demand for water are being improved. At present only 1% of domestic consumers in the Severn-Trent Water Authority region have a metered water supply. The current demand allocation and mapping package system accommodates domestic metered consumers; and users have the option to consider their demand as either measured or unmeasured consumption. This provision ensures that the system will not become redundant with the growth in measured domestic consumers. (See also W90-08776) (Mertz-PTT)
W90-08791

STATE ESTIMATION AND LEAK DETECTION IN WATER NETWORKS.
Ecole Nationale Superieure des Mines de Paris, Fontainebleau (France). Centre d'Automatique et Informatique.
G. Cohen, and P. Carpentier.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988.

p 317-332. 1 fig, 3 ref.

Descriptors: *Computer models, *Data requirements, *Leakage, *Maintenance, *Network analysis, *Water conveyance, Computer analysis, Data interpretation, Evaluation, Model studies, Observability, Pipe flow, Pseudo-measurements.

A water distribution network is observable if the measurements made on it allow the determination of the flow and head values for all pipes and nodes in the network. This article gives the algebraic conditions ensuring static observability and underlines the link with the graph theoretical approach. Unfortunately, water distribution networks are generally poorly instrumented, and the measurements are very often insufficient to ensure the observability conditions. Therefore, real measurements must be supplemented with pseudo-measurements concerning information derived from off-line observations (for example, node consumption dynamical models). Pseudo-measurements were incorporated in an optimization problem whose solution, when it is uniquely defined, provides the state estimation. The method used consists of minimizing a criterion which takes into account the pseudo measurement discrepancies, subject to the real measurement equations. The main difficulty of this approach lies in the choice of the pseudo measurements. Because the optimization problem solution depends on these pseudo measurements, it is important that these measurements are well adapted to the particular problem. For example, in the leak detection problem it is necessary that the pseudo measurements give nodal consumption variations whose statistical study allows leak localization. This can only be done by testing the adequacy between pseudo measurements and results in each particular case. (See also W90-08776) (Mertz-PTT)
W90-08792

COMPARISON OF THREE REAL-TIME STATE ESTIMATION METHODS FOR ON-LINE MONITORING OF WATER DISTRIBUTION SYSTEMS.
Durham Univ. (England). School of Engineering and Applied Science.
R. S. Powell, M. R. Irving, M. J. H. Sterling, and A. Usman.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 333-348. 3 fig, 3 tab, 11 ref.

Descriptors: *Computer models, *Computer programs, *Network analysis, *State estimation, *Water distribution, Comparison studies, Computer analysis, Computers, Data interpretation, Data quality control, Estimating, Fortran, Least squares method, Linear programming, Model studies, Monitoring, Water conveyance.

Three methods of real-time state estimation which have been implemented in FORTRAN 77 and tested using two different water distribution network models were examined. A state estimator is employed to remove bad data and to filter the signal noise, thus producing validated data that can be safely used to drive the various control schemes. A desirable characteristic for a state estimator used in the on-line monitoring of a water distribution system is therefore an ability to differentiate between gross errors and measurement noise. Results showed that the least absolute values minimization via the linear program or the re-weighted least squares method was the most suitable for use in real time monitoring and control of water distribution systems owing to the superior bad data rejection properties. For large scale systems, the re-weighted least squares approach was faster and more robust than the linear program. The algorithm was simple and therefore easy to implement in an existing least squares estimator. (See also W90-08776) (Mertz-PTT)
W90-08793

USE OF THERMODYNAMIC PUMP TESTING IN CONJUNCTION WITH WATER DISTRIBUTION NETWORK MODELS.
Severn-Trent Water Authority, Birmingham (England). Western Div.

E. S. Kain.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 349-362. 4 fig, 4 fig, 5 ref.

Descriptors: *Computer models, *Computer programs, *Cost analysis, *Model studies, *Network analysis, *Pump testing, *Water demand, *Water distribution, Cost allocation, Economic aspects, England, GINAS program, Maintenance, Thermodynamics, Water conveyance.

Thermodynamic pump testing, in conjunction with network modeling of the Birmingham, England distribution system was performed. The system serves a population of 1,250,000 and has an average daily consumption of 325 megaliters. Slightly less than half of the demand is met by pumping with an associated energy cost of 500,000 pounds per annum. The GINAS program was used in the initial analysis. The work showed that when considering whole life costs of pumping installations, the division of expenditure is: 10% initial capital costs; 5% maintenance costs; and 85% running costs. Each kilowatt of power consumed cost 1 pound/day, or 350 pounds per annum. Where motors rated at several hundred kilowatts were in continuous use the resulting running costs were considerable. In the Birmingham System it was demonstrated that measurement of pump efficiency can lead to cost savings. The use of the Yates Meter for measurement was found to be simple and accurate. The results obtained gave a reliable indication of pump condition. In most cases, the cost of the test amounted to little more than one day's running cost for the pump. (See also W90-08776) (Mertz-PTT)
W90-08794

FAULT ANALYSIS AND FLUID TRANSIENT SUPPRESSION IN PIPELINES AND NETWORKS.
City Univ., London (England). Thermo-Fluids Engineering Research Center.
A. R. D. Thorley, and D. J. Wood.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 363-382. 6 fig, 2 tab, 15 ref.

Descriptors: *Design criteria, *Hydraulic transients, *Maintenance, *Mechanical failure, *Network design, *Pipelines, *Water conveyance, Computer analysis, Computer models, Data interpretation, Forecasting, Model studies, Pipe flow, Pressure distribution.

The principal design features of pipeline systems or networks are usually based on expected or specified steady flows and pressures. During a subsequent stage of the design process the prudent engineer will speculate on the extent to which abnormal and fault conditions might occur and against which the pipe system and its associated plant must be protected. Typical hazards include pipeline collapse and rupture, leakage from or into the pipes, contamination of the environment or of the fluid in the pipe and damage to seals and electric motors. The final choice of surge suppression strategy is made on a combination of technical and economic criteria. Example calculations for transient flow analysis illustrate that comprehensive fault analyses may be carried out using a standard microcomputer. Extensive tabular and graphical results may be generated to enable the engineer to evaluate the transient performance of the pipe system and the effectiveness of proposed surge control devices. (See also W90-08776) (Mertz-PTT)
W90-08795

SIMULATION OF TRANSIENT PHENOMENA IN INTERNAL FLOW SYSTEMS.
Warwick Univ., Coventry (England). Dept. of Engineering.
A. P. Boldy.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 383-408. 16 fig, 14 ref.

Descriptors: *Computer models, *Hydraulic engineering, *Hydraulic transients, *Network analysis, *Network design, *Pipe flow, *Pressure distribution, *Simulation, *Simulation analysis, *Water conveyance, Computer analysis, Computers, Flow characteristics, Hydraulic design, Model studies.

Any internal flow system containing a fluid in motion can experience pressure transients defined as the time and space dependent variation of flow and pressure which occurs during the unsteady flow phase when a steady state flow changes to another steady state. Simple boundary conditions such as reservoir, surge tank, junction, valve, pump and turbine are encountered in internal flow systems and can be incorporated into computer programs for the simulation of transient phenomena. Computer simulations are based on the simultaneous consideration of the dynamic equilibrium and continuity equations describing the fluid motion within the hydraulic system together with the governing equations or performance characteristics of the boundary conditions of the system. Traditionally, this study was one of analysis rather than design or synthesis. A design is made, then the system is analyzed to see if it is satisfactory from a transient viewpoint. If not, alterations in the design are made, and the analysis repeated perhaps with introduction of surge protection devices such as air vessel or surge tank. Aside from damaging equipment attached to internal flow systems, pressure transients may cause the conduit to fail from excessive pressure or by collapse due to a static pressure less than atmospheric. Computer simulation of transient phenomena in internal flow systems shows that the interpolations usually associated with the methods of characteristics may be avoided in some situations. (See also W90-08776) (Mertz-PTT)
W90-08796

TRANSIENT HYDRAULIC ANALYSIS OF CONDUIT SYSTEMS IN MULTI-REGIME CONDITIONS.
Atkins (W.S.) International, Epsom (England).
S. J. Murray, A. G. Hooper, R. D. Searle, R. W. Paige, and S. N. Davies.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 409-429. 8 fig, 7 ref.

Descriptors: *Computer models, *Computer programs, *Hydraulic design, *Hydraulic transients, *Network analysis, *Network design, *Water conveyance, Computers, Hydraulic flow, Model studies, Steady flow.

The requirement to generate true worst case design conditions has prompted the development of a new software tool that can deal with a much greater variety of the conditions that may develop in a closed conduit hydraulic system. Software design specification was written with the intention not only to provide a means of analyzing complex transient multi-regime conditions, but also to perform other types of study normally encountered during the hydraulic design of a closed conduit system. With this in mind the following attributes were included: zero flow computation, steady state conditions, full pipe transient conditions, open channel transient conditions, regime combination, and boundary modules. The software design also included features that make the suite a highly usable tool for the engineer/analyst. The postprocessor offers the user a number of different types of access to the results file. Gridpoint time histories of relevant variables, boundary module variable time histories and a range of summary results can all be obtained in either graphical or listing form. The user has control, for the time history results, of the exact start and end points of the series and so specific time slices of interest can be examined. For pipe head profiles, the user must supply a list of suitably connected pipes. This allows long runs or single pipes only to be examined. (See also W90-08776) (Mertz-PTT)
W90-08797

THEORETICAL FOUNDATION AND EMPIRICAL FRAMEWORK FOR EVALUATING IN-

TERBASIN WATER TRANSFER POLICY: THE CASE OF SOUTH CAROLINA WATER SYSTEM.
Clemson Univ., SC.
For primary bibliographic entry see Field 7B.
W90-08798

COMPUTER APPLICATIONS IN WATER SUPPLY. VOLUME 2: SYSTEMS OPTIMIZATION AND CONTROL.
John Wiley and Sons, Inc., New York, New York. 1988. 438 p. Edited by Bryan Coulbeck and Chun-Hou Orr.

Descriptors: *Computer models, *Cost analysis, *Model studies, *Reservoirs, *Water conveyance, *Water demand, *Water supply, *Water treatment, Algorithms, Computer analysis, Computer programs, Computers, Conferences, Data interpretation, England, Evaluation, Forecasting, Optimization, Pumps, Valves, Water industry.

Supply and distribution systems for purified water typically consist of distribution networks of pipes, pumps, valves and reservoirs with external supplies from boreholes, rivers and lakes. Operating costs derive from manpower charges for support, electricity charges for pumping and chemical charges for treatment. Major requirements for control include: evaluation of network operation, prediction of future water demand and selection of pump schedules to meet this demand. Of increasing interest in modern control schemes is the concept of optimization of operation that attempts to achieve lowest operating costs consistent with providing a satisfactory service to consumers. A number of efficient algorithmic procedures and techniques have evolved for analysis, design and optimized control purposes. The commitment on the part of the water industry to apply these advanced methods has required the parallel development of user friendly computer programs incorporating the latest research results. This text consists of the edited proceedings of the International Conference--Computer Applications for Water Supply and Distribution, held September 8-10, 1987 at Leicester Polytechnic, England. Volume 2 covers computer-based techniques for data acquisition, measurement processing, mathematical modelling, cost optimization and operational control of water supply and distribution systems. (See also W90-08776 and W90-08800 thru W90-08821) (See also W90-08799) (Mertz-PTT)
W90-08799

TELEMETRY SYSTEM DESIGN AND ON-LINE DECISION SUPPORT WITH 'TCLAS' SOFTWARE.
Trent Polytechnic, Nottingham (England).
For primary bibliographic entry see Field 7A.
W90-08800

TELEMETRY SYSTEM CONTROL: THE RTK KERNEL--A GENERAL SOLUTION.
Information Processing Ltd., Bath (England).
P. S. Davis.
IN: Computer Applications in Water Supply. Volume 2: Systems Optimization and Control. John Wiley and Sons, Inc., New York, New York. 1988. p 12-30.

Descriptors: *Computer models, *Computer programs, *Data processing, *Telemetry, Computers, Economic aspects, England, Kernel, Metropolitan water management, Model studies, Water delivery, Water management, Water users.

The Bristol Waterworks Company and Information Processing Limited have together specified and developed a suite of application programs, called the RTK Kernel, to provide the functions needed in a generalized telemetry network control system. The system provides advanced facilities for control room operators and is designed to be integrated with other computer systems such as the large networked systems installed by companies like Bristol Waterworks Company to support customer services and accounting facilities. The primary objective of the model behind the Kernel was to isolate functions that could be generalized

from those that must be considered to be installation-specific. The generalized functions, and hence those to be supported by the Kernel, were seen to be support of the operator man-machine interface and maintenance of the telemetry network definition and current point-values. (See also W90-08799) (Mertz-PTT)
W90-08801

LOCAL INTELLIGENT PUMPING--A STANDARD APPROACH.
SPP Controls Ltd., Reading (England).
R. Record.
IN: Computer Applications in Water Supply. Volume 2: Systems Optimization and Control. John Wiley and Sons, Inc., New York, New York. 1988. p 31-42. 17 fig, 1 ref.

Descriptors: *Automation, *Pumps, *Water conveyance, *Water treatment facilities, Computers, Cost analysis, Economic aspects, Optimization, Pipe flow, Pumping, Water pressure.

The reduction in costs of electronics will make local pump control more widely available and allow an increasing proportion of pump applications to benefit from resulting improvements in efficiency and automation. A standardized approach treating pumps and control systems as a single package enables the pumping device to be optimized to the system in question. Locally controlled pumps can provide substantial advantages over conventional constant pump sets, particularly in terms of the achievable economics of operation. The interrelationship between pump and controls can be complex and it makes sense to consider the whole as a single integrated unit comprising pumps, switchgear and control system. The configuration of the unit for specific application could be based on the pumping functions required such as system pressure requirements, flow-time relationships, and monitoring and interfacing requirements. These could be optimized on total life cycle costs. (See also W90-08799) (Mertz-PTT)
W90-08802

CONFIDENCE LIMIT ANALYSIS IN WATER SYSTEMS.
Trent Polytechnic, Nottingham (England).
A. Bargiela, and G. D. Hainsworth.
IN: Computer Applications in Water Supply. Volume 2: Systems Optimization and Control. John Wiley and Sons, Inc., New York, New York. 1988. p 43-58. 4 fig, 3 tab, 10 ref.

Descriptors: *Pipe flow, *Statistical analysis, *Water conveyance, *Water metering, *Water pressure, *Water treatment facilities, Algorithms, Computer analysis, Model studies, Monte Carlo simulation, Optimization, Sensitivity analysis, Simulation.

The various factors involved in how the measurement errors are passed on to the calculated flows and pressures in water distribution systems were examined. These factors included the distribution of meters throughout the network, meter accuracy and network topology. Based on this analysis, two efficient algorithms for quantification of confidence limits on flows and pressures have been proposed. The first one uses an optimization approach and the second makes use of sensitivity analysis. The performance of these algorithms is assessed in terms of their suitability for real-time control or design stage applications. The results obtained were verified against a Monte Carlo simulation method. The Monte Carlo simulation technique generates a set of feasible state estimates and from these calculates upper and lower error bounds for each state variable. Both the optimization and the sensitivity matrix methods were based on a linearized system model. The results produced by these methods compared very well with the results of the Monte Carlo simulations. The computational efficiency of the sensitivity algorithm renders it suitable for on-line decision support applications. (See also W90-08799) (Mertz-PTT)
W90-08803

OPERATIONS CONTROL SYSTEMS IN THE WATER INDUSTRY: WHAT, HOW, AND WHERE TO.
Holloway Associates, Weybridge (England).
K. H. Benjamin.
IN: Computer Applications in Water Supply. Volume 2: Systems Optimization and Control. John Wiley and Sons, Inc., New York, New York. 1988. p 59-79. 2 fig, 1 tab, 4 ref.

Descriptors: *Computer models, *Control systems, *Operating policies, *Water conveyance, *Water management, Central control, Computer analysis, Computers, England, Local control, Model studies, Water control, Water delivery.

The evolution of Operations Control Systems in the United Kingdom Water Industry is related to important advances in technology. Two lines of operations control systems exist: The first line is called CDCC (Centrally Directed-Centrally Controlled). These maintain the coordination of the whole operations control system at a control center. The second development, called CDLC (Centrally Directed-Locally Controlled), utilizes not only distributed processing, but also the technique of management by exception. Such a system is based on the proposition that outstations are largely or fully autonomous. In considering the future of operations control systems, their association with other important information technology is important. Transactions with a modelling system, post hoc data analysis facilities, a digital mapping system, and the organization resources management system are essential. The Centrally Directed-Centrally Controlled philosophy provides actual data, which is reassuring to operators at the central site. The price for this is maintaining continuous, but intermittent communications to all relevant outstations. The Centrally Directed-Locally Controlled system uses synthetic data for all normal purposes. The proposition is that each active outstation is working under an operating schedule. The newer locally controlled systems offer greatly enhanced system integrity, requiring only moderate capacity and response for its links. Since the costs of reliable communication rise dramatically as capacity and response performance are increased, it is to be expected that capital and running costs are greatly reduced by using local control, instead of central control. (See also W90-08799) (Mertz-PTT)
W90-08804

REVIEW OF METHODOLOGIES FOR MODELLING AND CONTROL OF WATER SUPPLY.
Leicester Polytechnic (England). Water Control Unit.
B. Coulbeck.
IN: Computer Applications in Water Supply. Volume 2: Systems Optimization and Control. John Wiley and Sons, Inc., New York, New York. 1988. p 80-109. 10 fig, 23 ref.

Descriptors: *Computer models, *Control systems, *Management planning, *Model studies, *Optimization, *Water control, *Water conveyance, Algorithms, Computer analysis, Computers, Cost analysis, Pipe flow, Pumps, Reservoirs, Valves, Water demand.

The specific and unique features of water supply and distribution systems and the complexity of the modelling and control tasks have been investigated for many years. As a result, a number of algorithmic procedures and techniques have evolved for dynamic modelling and optimized control purposes. Typical systems consist of multi-reservoir networks incorporating pipes, pumps and valves to supply the varying water demands. The pump flows are dependent upon the reservoir levels and the pump operating costs upon electricity unit and demand charges. From a theoretical viewpoint, water systems are large-scale, non-linear and highly interactive. Optimization must cater for combinations of discrete and continuous control variables and must allow for state and control constraints. Since water networks contain storage, the optimization problem reduces to minimization of electricity charges and associated costs for the complete network over the entire control period. The successful application of optimization methods

depends significantly upon the formulation of simplified dynamic models for rapid and repeated evaluation of the effects of control strategies upon the network operation. A prediction scheme is also required that will provide a forecast of consumer demands for the complete control period. To avoid unnecessary experimental manipulation of operational systems, system analysis and initial validation of results must rely upon accurate simulation methods. (See also W90-08799) (Mertz-PTT)
W90-08805

OVERVIEW OF IMPORTANT ISSUES IN OPERATIONAL FLOOD CONTROL.
Politechnika Warszawska (Poland). Inst. of Automatic Control.
For primary bibliographic entry see Field 4A.
W90-08806

ROBUST DIGITAL CONTROL OF VALVES IN A LARGE WATER NETWORK.
Instituto de Ingenieria Cibernetica, Barcelona (Spain).
J. Quevedo, G. Cembrano, J. M. Montoliu, and F. Casanova.
IN: Computer Applications in Water Supply. Volume 2: Systems Optimization and Control. John Wiley and Sons, Inc., New York, New York. 1988. p 146-164. 23 fig, 4 ref.

Descriptors: *Computer models, *Control systems, *Hydraulic valves, *Water control, *Water conveyance, Algorithms, Computer analysis, Computers, Model studies, Performance evaluation, Simulation.

The design of robust digital controllers for valves in a water distribution network was examined. Four linear and nonlinear digital control algorithms for valves were studied and a comparative analysis of the performances was carried out based on the simulation results obtained with analytical models for valve behavior. The first controller uses nonlinear control with identical threshold and hysteresis. This controller consists mainly of switching the opening or closure of the valve whenever the control error is greater or lower than a predefined threshold. The valve continues to open or close until the error goes to zero (hysteresis). The second controller uses nonlinear control with threshold, hysteresis and dead zone. Limit cycles may be avoided by decreasing the hysteresis parameter so that the opening or closure action is switched off before the output variable reaches the desired value. The third controller achieves nonlinear control through pulse-width modulation. This alternative control strategy intends to overcome the inconvenience of having only three possible actions (open-stop-close), to be performed at a fixed speed, by introducing a pulse width modulation according to a characteristic curve. The fourth option keeps the nonlinear module with identical threshold and hysteresis, but takes into account not only the error variable but also its derivative. This fourth option is called the proportional-derivative controller. Results indicated that the best choices of controllers were the use of a dead zone and pulse-width modulation, since they provide a better response of the valve in terms of stability and precision, than could be achieved with the initial controller and they do not involve an excessively large number of switching operations, as is the case in the proportional-derivative controller. (See also W90-08799) (Mertz-PTT)
W90-08807

APPLICATIONS REVIEW OF MODELLING AND CONTROL OF WATER SUPPLY AND DISTRIBUTION SYSTEMS.
Leicester Polytechnic (England). Water Control Unit.
B. Coulbeck, and C. H. Orr.
IN: Computer Applications in Water Supply. Volume 2: Systems Optimization and Control. John Wiley and Sons, Inc., New York, New York. 1988. p 165-186. 17 fig, 15 ref.

Descriptors: *Computer models, *Computer programs, *England, *Model studies, *Water control, *Water conveyance, Computer analysis, GINAS

program, GIPADS program, Optimization, Pumping, Scheduling, Simulation analysis, Water supply.

Applications projects and procedures concerned with modelling and control of water supply and distribution systems are being investigated by the Leicester Polytechnic Water control Unit. This work has resulted in the development of a suite of computer programs covering dynamic simulation and optimization scheduling. Projects (all in the United Kingdom) include optimized control of the Grafham water supply scheme, fully automated control of Wolverhampton water supply scheme, simulation of the London water ring main, and optimized control of the River Derwent supply scheme. Two programs are available for computer-aided design and evaluation of pump stations and distribution networks. The GIPADS (Graphical Interactive Pump-source Analysis, Design and Simulation) program provides comprehensive facilities for modelling, analysis and simulation of pumps and pump-source systems. GINAS (Graphical Interactive Network Analysis and Simulation) is a general purpose program and is applicable to most types of water supply and distribution systems. Two other programs are used for optimized source selection and pump scheduling. GIPOS (Graphical Interactive Pump Optimization and Scheduling) provides facilities for optimal pump selection and scheduling for groups of parallel, fixed speed and variable speed pumps. GIMPOS (Graphical Interactive Multi-station Pump Optimization and Scheduling) contains similar facilities to GIPOS but has been specially written to perform optimized pump scheduling for multiple pump stations. Demand analysis and prediction is performed with GIDAP (Graphical Interactive Demand Analysis and Prediction). (See also W90-08799) (Mertz-PTT)
W90-08808

MODELLING OF WATER TREATMENT WORKS.
Halcrow (William) and Partners, Swindon (England).
E. P. Evans, and J. M. Buckley.
IN: Computer Applications in Water Supply. Volume 2: Systems Optimization and Control. John Wiley and Sons, Inc., New York, New York. 1988. p 187-207. 9 fig, 1 tab, 11 ref.

Descriptors: *Computer models, *England, *London, *Model studies, *Water conveyance, *Water treatment facilities, Computer analysis, Filtration, Hydraulic valves, Mathematical studies, Water control, Water pretreatment, Water treatment.

A general purpose network simulation program (SIM), suitable for water treatment works, was applied to two case studies that supply water to the greater London area. The program is data-steered and solves the equations by a sparse matrix routine using functional iteration with under-relaxation. Special attention is drawn to the equations, the modelling of pumps, and boundary conditions. The Ashford Common Water Treatment Works is the most recently constructed in the Thames Valley and supplies about 25% of the total group demand. As a result of SIM trials, several recommendations were made for Ashford Common. The existing rotary microstrainers should be replaced by a new primary filtration plant, improved bed cleaning operations and sand washing capabilities would be required, and automatic control of secondary filter inlet and outlet valves and remote operation of top and bottom drain valves and recirculation system is essential for reliable operation. It was also recommended that a dynamic hydraulic simulation model of the works be constructed. The Coppermills Water Treatment Works is located in the Lee Valley and is the major supplier of the potable water to north and north-east London. Based on similar work done at Ashford Common, a hydraulic simulation model was created for the works. This model will be used to assess maximum allowable head loss across the primary filters and provide an on-site implementation to assist in future operational management of the works at the proposed uprated flows. (See also W90-08799) (Mertz-PTT)

W90-08809

SIMPLIFICATION OF WATER SUPPLY DISTRIBUTION SYSTEMS FOR OPTIMAL OPERATIONS.
Tongji Univ., Shanghai (China). Dept. of Environmental Engineering.
Y. C. Chen.
IN: Computer Applications in Water Supply. Volume 2: Systems Optimization and Control. John Wiley and Sons, Inc., New York, New York. 1988. p 208-225. 3 fig, 2 tab, 10 ref.

Descriptors: *Computer models, *Mathematical studies, *Model studies, *Stochastic models, *Water conveyance, *Water treatment facilities, Computer analysis, Computers, Cost analysis, Operating costs, Regression analysis.

A piecework macroscopic model was developed to suit general water supply distribution systems that do not satisfy the condition of proportional loading. Instead of adapting the usual regression method, the concept of an equivalent network is introduced. The macroscopic model can be, for the purpose of control, the equivalent of a full network model. It is convenient and feasible for on-line implementation, and is also effective for those systems having only partial information available, because of the stochastic nature of water consumption and the constant change in hydraulic network characteristics. The model was constructed through the presentation of well-known nodal equations for a network. Based on conventional methods of water supply analysis, the concept of an equivalent network appears to be stronger theoretically and is more accurate and reliable for simulation and control purposes. Savings in the total costs of water supply can be obtained by optimization of system operations. (See also W90-08799) (Mertz-PTT)
W90-08810

SUBOPTIMAL APPROACH TO SCHEDULING OF RESERVOIR LEVELS FOR A MULTI-RESERVOIR WATER DISTRIBUTION NETWORK.
Politechnika Warszawska (Poland). Inst. of Automatic Control.
P. Tatjewski.
IN: Computer Applications in Water Supply. Volume 2: Systems Optimization and Control. John Wiley and Sons, Inc., New York, New York. 1988. p 225-239. 10 fig, 4 tab, 9 ref. Polish Government Research Program PR7, grant PR-7.01.05.01.

Descriptors: *Computer models, *Control systems, *Model studies, *Pumping plants, *Reservoir operation, *Water control, *Water conveyance, Computer analysis, Computers, Pumps.

A suboptimal approach to solving a nonlinear discrete time optimal control problem with continuous and integer variables arising at the higher level of the multilayer control structure for multireservoir water distribution networks was examined. The idea of the approach is to approximate the mentioned problem by a simpler one. The crucial step in the simplification process is replacement of the integer variables by continuous ones. This can be achieved by approximating characteristics of pumping stations by unique, continuous curves. It is possible only for certain, limited classes of pumping stations and networks, however, and mainly for large pumping stations consisting of many smaller identical fixed speed pumps connected in parallel. The approximation process is not automatic and good knowledge of the network plays a significant role. After solving the approximate problem the obtained reservoir levels (or reservoir outflows) are the only information that is further utilized. Under prescribed values of reservoir outflows the original decision variables can then be easily evaluated using the original network model, independently for each time instant. This methodology cannot be applied automatically, its success depends to a great extent on good understanding of the given network and on some specific features of the network. (See also W90-08799) (Mertz-PTT)
W90-08811

OPTIMAL SCHEDULING OF A CLASS OF WATER SUPPLY SYSTEMS CONTAINING ONLY FIXED SPEED PUMPS.
Leicester Polytechnic (England). Water Control Unit.
M. Brdys, B. Coulbeck, and C. H. Orr.
IN: Computer Applications in Water Supply. Volume 2: Systems Optimization and Control. John Wiley and Sons, Inc., New York, New York. 1988. p 240-258. 13 fig, 10 tab, 16 ref.

Descriptors: *Computer models, *Cost analysis, *Mathematical studies, *Model studies, *Pumps, *Water conveyance, *Water supply, Algorithms, Computer analysis, Pipes, Pumping plants, Reservoirs.

The problem of optimal scheduling in water supply systems containing only fixed speed pumps has been considered. Direct search techniques were used to solve the problem. This involved applying all possible control trajectories and evaluating the corresponding costs, with feasibility determined by network simulation. This is particularly attractive if there are no continuous control variables within the system because there is only a finite number of control trajectories. The direct search technique was applied to a very simple system composed of one reservoir, one pump station containing two pumps of the same hydraulic characteristics, and one coupling pipeline with distributed demands. A time horizon of 24 hours was split into three time stages of different length giving 27 possible pump schedules. The cost corresponding to a given schedule was evaluated on an hourly basis. Two new algorithms, which do not utilize the classical approach of dynamic programming for this kind of problem were successfully applied to the physical water supply systems. The solution to this example indicates that direct search is applicable to only very small problems. (See also W90-08799) (Mertz-PTT)
W90-08812

OPTIMIZATION OF URBAN WATER DISTRIBUTION SYSTEMS.
Tongji Univ., Shanghai (China). Dept. of Environmental Engineering.
Q. Yang.
IN: Computer Applications in Water Supply. Volume 2: Systems Optimization and Control. John Wiley and Sons, Inc., New York, New York. 1988. p 259-278. 3 fig, 16 ref.

Descriptors: *Computer models, *Cost analysis, *Design criteria, *Model studies, *Optimization, *Pipelines, *Pumping plants, *Water conveyance, Conveyance structures, Economic aspects, Water management, Water use.

An approach to optimize the layout of a water distribution system with boosting pumping station on pipe line and a reservoir with pumping station at the end of networks was examined. The method was to optimize the distribution of discharge based on the optimized head-drops. It was assumed that a preliminary skeleton of networks and hourly nodal water consumption was carefully determined by the present and predicted future conditions. The aim was to determine the most economical diameters of all lines. The process was divided into two stages: first, to optimize the head-drops of each line under the given feasible discharge distribution and second, to optimize the discharge distribution under the optimized head-drops. The process was repeated many times, until consistency was attained. Optimization was based on the minimum and maximum hourly consumption. Theoretically, the amount of different sets of chords could be enormous, but practically it was not necessarily so, because in consideration of topography, conditions and requirements of consumers, many of them were eliminated. In the end, a set of diameters of standard size satisfying the requirements of the operation were obtained. (See also W90-08799) (Mertz-PTT)
W90-08813

PUMP SCHEDULING IN WATER SUPPLY: MORE THAN A MATHEMATICAL PROBLEM.
WRc Engineering, Swindon (England).

J. D. Creasey.
IN: Computer Applications in Water Supply. Volume 2: Systems Optimization and Control. John Wiley and Sons, Inc., New York, New York. 1988. p 279-289. 4 fig.

Descriptors: *Computer models, *Cost analysis, *Mathematical studies, *Pumping, *Water conveyance, Computer analysis, Data collections, Economic aspects, England, Model studies, Optimization, Pumps, Water supply.

The practical difficulties involved in pump scheduling were examined. These include: the interface between the water supply engineer and the numerical technique; the problem posed by the monthly maximum demand charge; and data collection. Consideration was given to the implementation of computer-generated schedules. While mathematical methods have been extensively researched to solve this problem, reducing costs becomes the key objective. Optimization methods, the interface between mathematical method and water supply operations, the investigation of pump schedules in a given system, implementation of a solution, and the WRc computer program OPTIONS were used. It was concluded that better pump scheduling could save the United Kingdom Water Industry around 10 million pounds per year. Mixed integer linear programming offered the best potential to achieve these savings. Because the investigation of pumping in a complex system was a major task, the amount of work involved in data collection should not be underestimated. Choosing the appropriate style of implementing scheduling schemes required careful consideration of system complexity and cost saving potential. (See also W90-08799) (Mertz-PTT)
W90-08814

PRACTICAL APPLICATION OF COMPUTER AIDED SIMULATION AND OPTIMIZATION TO THE LEICESTER WATER SUPPLY MELBOURNE AQUEDUCTS SYSTEM.
Severn-Trent Water Authority, Leicester (England). Eastern Div.
K. Blease.
IN: Computer Applications in Water Supply. Volume 2: Systems Optimization and Control. John Wiley and Sons, Inc., New York, New York. 1988. p 290-312. 16 fig, 6 ref.

Descriptors: *Computer-aided design, *Conveyance structures, *Model studies, *Optimization, *Pumping plants, *Storage reservoirs, *Water treatment facilities, Computer models, Computer programs, England, Pipelines, Simulation, Water conveyance, Water demand, Water supply, Water treatment.

Computer aided simulation and optimization was applied to a major water treatment works, aqueducts and terminal reservoirs system. The Melbourne aqueducts system supplies Soar Division of the Severn Trent Water Authority (England) with 165 megaliters of water, which is 65% of the total daily demand. At the Melborune Water Treatment Works two high lift variable speed pumping stations deliver water to Leicester along two large diameter pipelines. These pipelines have supplies en route and terminate at two storage reservoirs from where water is conveyed to the city and county of Leicester. Network models were prepared using standard programs, and site trials completed to calibrate those models. An operational system of pump scheduling was formulated, and this was followed by the development of a computer program by the Leicester Polytechnic which would be used to automatically predict demand and the resulting water treatment works pumping station flow for the following 24 hour period. The program, which was compiled on a Prime mini computer, will eventually be mounted on an IBM microcomputer. The computer programs have proved to be both accurate and reliable, and confidence has been gained in their future use. (See also W90-08799) (Mertz-PTT)
W90-08815

COMPUTER TECHNIQUES FOR ON-LINE CONTROL OF WATER SUPPLY NETWORKS.
Cambridge Univ. (England). Dept. of Engineering.
F. Fallside.
IN: Computer Applications in Water Supply.
Volume 2: Systems Optimization and Control.
John Wiley and Sons, Inc., New York, New York.
1988. p 313-328. 5 fig, 7 ref.

Descriptors: *Computer models, *Cost analysis, *Model studies, *Pumping, *Water conveyance, *Water treatment facilities, *Water use, Computer analysis, Computers, England, Forecasting, Metropolitan water management, Optimization, Telemetry, Water management.

More than 10 years ago a project was carried out on the East Worcestershire Waterworks Company (England) network to provide automatic scheduling of pumps to meet consumption demand at minimum cost. The project produced a predictor-optimizer control scheme in which consumptions were predicted 24 hours ahead and a minimum-cost pumping schedule was calculated for these predictions. In one phase of the project a minimum system was studied in which a reduced number of measurements and control inputs were assumed to be available compared to the number of East Worcestershire Waterworks Company; the aim was to allow the method to be extended to other networks. Arising from the work were two recommendations for further research. (1) A study of day-ahead prediction of the day's consumption for an outstation, on the basis that second and future generation telemetry-telecontrol schemes were tending towards distributed computing and that this parameter was a key one in automatic pump scheduling. (2) A study of the addition of a control computer to a network without telemetry or tele-control for purposes of automatic pump scheduling, including an investigation of the effects of minimum, manual sampling frequency. (See also W90-08799) (Mertz-PTT)
W90-08816

REAL-TIME FORECASTING AND CONTROL FOR WATER DISTRIBUTION.
Heriot-Watt Univ., Edinburgh (Scotland). Dept. of Civil Engineering.
P. W. Jowitt, R. T. Garrett, S. C. Cook, and G. Germanopoulos.
IN: Computer Applications in Water Supply.
Volume 2: Systems Optimization and Control.
John Wiley and Sons, Inc., New York, New York.
1988. p 329-355. 13 fig, 1 tab, 3 ref.

Descriptors: *Computer models, *Cost analysis, *England, *Model studies, *Pumping, *Water conveyance, Computer analysis, Computer programs, Control systems, Electrical power demand, Optimization, Simulation, Water pressure.

A real-time operational control of a water distribution system was applied to Thames Water. The daily production of adaptable pump schedules derives from an optimization of unit and maximum demand electricity costs based on linear programming, followed by an implementation algorithm which transforms the linear programming output into practical and comprehensible schedules. The optimization was supported by an extended period hydraulic and cost simulation model capable of modelling pressure dependent demands and leakage, and supporting any selected electricity tariff. A major aspect of this work has been an ease of implementation by typical distribution operators, and considerable effort has been made in the development of software to re-interpret optimization output into user comprehensible schedules and user displays. The success of the work has been founded on an in-depth knowledge of the network, its particular characteristics and close liaison with operational staff. (See also W90-08799) (Mertz-PTT)
W90-08817

OPTIMAL OPERATION OF WATER SYSTEMS.
Sociedad General de Aguas de Barcelona (Spain).
J. L. Solanas, and J. M. Montoliu.
IN: Computer Applications in Water Supply.

Volume 2: Systems Optimization and Control.
John Wiley and Sons, Inc., New York, New York.
1988. p 356-375. 14 fig, 6 tab, 9 ref.

Descriptors: *Algorithms, *Computer models, *Computer programs, *Management planning, *Model studies, *Optimization, *Water conveyance, Control systems, Forecasting, Mathematical studies, Water control, Water demand.

An efficient algorithm and computer program to determine the optimal operation of a complex water system for a 24 hour period was developed. A five stage methodology to obtain optimal operation of a water system entailed: (1) first level modelling of the system; (2) demand forecasting for distribution networks; (3) equivalent modelling of distribution networks; (4) second level modelling of the system; and (5) telecontrolling the system. Partial c-dimensional dynamic programming proved a simple and effective method that was appropriate for solving the optimal operation of water systems. The algorithm produced smooth successive increments at the independent variables. This took advantage of a theoretical search on the complex hyperpoliedrical nature of the problem. In the end, the whole methodological approach, and not just a computer program or mathematical algorithm, was needed to solve the optimal operation problem. (See also W90-08799) (Mertz-PTT)
W90-08818

OPTIMAL CONTROL OF THE WEST PARISIAN AREA WATER SUPPLY NETWORK.
Lyonnaise des Eaux, Paris (France).
P. Alla, and P. A. Jarrige.
IN: Computer Applications in Water Supply.
Volume 2: Systems Optimization and Control.
John Wiley and Sons, Inc., New York, New York.
1988. p 376-391. 5 fig, 6 ref.

Descriptors: *Computer models, *Control systems, *France, *Model studies, *Optimization, *Paris, *Water conveyance, Computer programs, Economic aspects, Forecasting, Mathematical studies, Metropolitan water management, Water control, Water demand, Water management.

The West Parisian Area (France) network supplies a population of approximately 1,000,000 with an average daily production of 275,000 cu m. Water distribution is regulated by a single control center provided with all the information it needs through a supervisory control and data acquisition system. The West Parisian Area regional office of Lyonnaise des Eaux has been equipped with computer-aided optimal decision-making software, using daily water demand forecasts. This tool calculates the optimal control (with regard to economic criteria) of the network facilities using decomposition-coordination, aggregation-desegregation and dualization methods. The process is split into two steps, one offline (main calculation of the interactions between the sub-networks and their Bellman functions), and one online (hourly feedback using these previous calculations and the actual reservoirs levels). The excellent theoretical behavior of this model has to be tempered by some management constraints which are not completely taken into account. The system has been under operation since 1985. (See also W90-08799) (Mertz-PTT)
W90-08819

COMPUTER CONTROL OF WATER SUPPLY AND DISTRIBUTION SYSTEMS: STRUCTURES, ALGORITHMS AND MANAGEMENT.
Leicester Polytechnic (England). Water Control Unit.
C. H. Orr, B. Coulbeck, M. Brdys, and M. A. Parker.
IN: Computer Applications in Water Supply.
Volume 2: Systems Optimization and Control.
John Wiley and Sons, Inc., New York, New York.
1988. p 392-420. 1 fig, 28 ref.

Descriptors: *Computer models, *Control systems, *Telemetry, *Water conveyance, *Water management, Computer analysis, Computers, Data acquisition, Forecasting, Model studies, Optimization, Simulation, Water demand.

Recent advances in computer technology have resulted in reliable and sophisticated telemetry monitoring and regulating systems being installed within existing water networks. One of the first tasks during the design of water systems control is to define the control objectives pertaining to the existing water network configuration and available telemetry resources. All the system components and their characteristic modes of operation must be considered. The next stage is to identify the available applications packages for network simulation, optimization and demand prediction and to utilize the techniques most appropriate to the particular water network. The analysis and management of the vast quantities of data must be performed efficiently in order to maintain a reliable control scheme. It may also be possible to make use of intelligent knowledge based systems in order to build up a computerized knowledge base that may be applicable to a particular network. Using these techniques, it is possible to integrate human reasoning, judgement and experience together with applications and control software so that the overall real-time control schemes can be implemented based upon a wealth of technical and qualified information. (See also W90-08799) (Mertz-PTT)
W90-08820

DISTRIBUTION SYSTEM MANAGEMENT AND CONTROL OPTIMISATION.
North Surrey Water Co., Staines (England).
E. G. Moss, and K. Howard.
IN: Computer Applications in Water Supply.
Volume 2: Systems Optimization and Control.
John Wiley and Sons, Inc., New York, New York.
1988. p 421-433. 2 fig, 1 ref.

Descriptors: *Computer models, *Computer programs, *Control systems, *England, *Model studies, *Telemetry, *Water control, *Water conveyance, *Water management, Computer analysis, Computers, Data interpretation, Simulation, Water demand, Water use.

The flexibility of modern telemetry and control systems, allowing much greater control of water sources and distribution systems, has increased the demand for on-line optimization. A system was developed for the North Surrey Water Company, England. North Surrey covers an area of 200 square miles and serves a population of 466,000. The area is in the London commuter belt and is mainly residential, with a few large customers. A computer model was developed in two phases. The first phase was to determine the critical points of the system and to meet the user requirement by developing a simulation of the system that could be executed in a fraction of a second on a microcomputer. The second phase was to develop the optimization method, to provide the on-line links to the telemetry system. The software package comprises four computer programs: (1) A program to generate network analysis runs and abstract data for the response functions; (2) The program to generate the response functions; (3) A program to evaluate the response functions and compare with the results of field tests; and (4) The main simulation and optimization system. With the system only recently completed and awaiting installation at the new Egham control center, it is not currently possible to give detailed user experience. (See also W90-08799) (Mertz-PTT)
W90-08821

WATER CONTAMINATION AND ESOPHAGEAL CANCER AT GASSIM REGION, SAUDI ARABIA.
King Faisal Specialist Hospital and Research Centre, Riyadh (Saudi Arabia). Dept. of Oncology and Biological and Medical Research.
M. H. Amer, A. El-Yazigi, M. A. Hannan, and M. E. Mohamed.
Gastroenterology GASTAB, Vol. 98, No. 5,1, p 1141-1147, May 1990. 2 fig, 3 tab, 25 ref.

Descriptors: *Cancer, *Drinking water, *Oil pollution, *Saudi Arabia, *Water pollution effects, *Well water, Cadmium, Calcium, Carcinogens, Chromium, Cobalt, Epidemiology, Human diseases, Hydrocarbons, Iron, Magnesium.

Group 5F—Water Treatment and Quality Alteration

Between January 1980 and December 1982, 183 patients with histologically confirmed carcinoma of the esophagus who were referred to a tertiary referral hospital were studied. Thirty-two (17%) patients were referred from Gassim Region in the north central part of Saudi Arabia. A case-control study showed a significant regional difference within Saudi Arabia and the most referrals for esophageal cancer from the Gassim area. When patients from Gassim Region were compared with those referred from other locations, no statistical differences were noted between the two groups except for the source of the drinking water. Water analysis from Gassim area showed a high solid content with elevated levels of calcium, magnesium, and to a lesser extent, chromium, iron, cadmium, and cobalt. Traces of petroleum oil were found in five of six water samples from Gassim during 1983, compared with 3 of 49 samples from other areas. Mutagenicity tests on water specimens from Gassim Region indicated the presence of possible carcinogens. It is suggested that the high prevalence of esophageal cancer in this region may be related to contamination of water by impurities such as petroleum oils. (Author's abstract)
W90-08939

LONGITUDINAL STUDY OF RAINFALL AND COLIFORM CONTAMINATION IN SMALL COMMUNITY DRINKING WATER SUPPLIES.
Dartmouth Medical School, Hanover, NH. Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W90-08948

CONTINUOUSLY REGENERATED GREEN-SAND FILTER FOR H2S REMOVAL FROM INDIVIDUAL WATER SUPPLIES.
Clemson Univ., SC. Dept. of Agricultural Engineering.
D. E. Brune, and R. L. Perez.
Journal of Environmental Science and Health (A) JESEDU, Vol. 25, No. 1, p 1-20, January 1990. 2 fig, 1 tab, 10 ref.

Descriptors: *Drinking water, *Filters, *Hydrogen sulfide, *Water treatment, Cost analysis, Domestic water, Pollutant removal.

Hydrogen sulfide contamination of individual home water supplies is a frequent problem in areas with aquifers in sedimentary rock. Commercially available systems for removal of H2S are often quite expensive. A new design is described for a low-cost oxidizing filter that has been successfully used to remove in excess of 99% of H2S (at concentrations of 1-5 mg/l) from the authors' home water supply for over 4 yr. The unit used continuously regenerated, parallel flow greensand filters. The system may be constructed from locally available materials (PVC pipe and fittings, greensand, chemical injection pump, and potassium permanganate) with a total cost ($326 for first year, $30/yr thereafter) of 25% of existing commercial units. (Author's abstract)
W90-08959

TARIFF REDUCTION BY SEGREGATION AND RECYCLING OF A WATER SLUDGE DISCHARGE IN SINGAPORE.
Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering.
A. Appan.
Journal of Environmental Science and Health (A) JESEDU, Vol. 25, No. 1, p 29-46, January 1990. 4 fig, 6 tab, 14 ref.

Descriptors: *Singapore, *Sludge disposal, *Water treatment, Backwash, Cost analysis, Filtration, Management planning, Recycling.

In a conventional water treatment plant in Singapore, a levy was being paid for directly discharging sludge (from flocculators, clarifiers, and filters) into a nearby public sewer. Site configuration and high treatability costs ruled out the possibility of in situ facilities for treatment of the alum-lime sludge. A study was undertaken to assess the impact of recycling some of the less potent fractions of this sludge and to appraise the economic viability of

this approach. Dewatering and cleaning of the flocculators produced the most potent sludge, whereas the filter backwash accounted for the largest fraction (72.5%) of the total waste volume. Using samples of the filter backwash blended with influent raw water, it was ascertained that the impact on the raw water quality was negligible and the settling characteristics improved, but there was a marginal increase in coagulant dosages. Based on costs of collecting and pumping filter backwashes and a resulting decrease in discharge volumes of sludge to public sewers, there can be a saving of Singapore Dollars 207,000 in the annual operating costs, which include the recycling of at least 2.6% (or about 900,000 cu m/annum) of the throughput. (Author's abstract)
W90-08961

FACTORS AFFECTING WATER-SUPPLY POTENTIAL OF THE TWIN CITIES METROPOLITAN AREA AQUIFER SYSTEM.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-08975

VIRUSES AND DRUG RESISTANT BACTERIA IN GROUNDWATER OF SOUTHEASTERN MINNESOTA.
For primary bibliographic entry see Field 5B.
W90-08978

EFFECTS OF CLIMATE VARIATION OF PUBLIC WATER SUPPLY.
Central Forecast Office, Lusaka (Zambia). Dept. of Meteorology.
For primary bibliographic entry see Field 2B.
W90-09104

LINEAR WATER-SUPPLY PIPELINE CAPACITY EXPANSION MODEL.
Lower Colorado River Authority, Austin, TX. Water and Wastewater Utilities Program.
For primary bibliographic entry see Field 8B.
W90-09190

TRANSMISSION MAIN ANSWERS WATER WOES.
R and D Engineering and Land Surveying, Buffalo, NY.
N. Randell.
Public Works PUWOAH, Vol. 121, No. 5, p 73-76, May 1990. 1 fig, 3 tab.

Descriptors: *Governmental interrelations, *Municipal water, *Project planning, *Regional planning, *Water conveyance, *Water distribution, *Water policy, New York State, Public policy, Water costs, Water law, Water management, Water supply, Water supply development.

Representatives of the Seneca Nation, the Village of Silver Creek, the lake-side townships of Evans and Hanover (New York State) and a Buffalo firm initiated a joint venture to provide the participating communities with safe drinking water at savings by building a 13-mile water transmission main, using concerted municipal cooperation, legal maneuvering, planning, and patience. Hanover's long-time supplier, the Village of Silver Creek, was under mandate from the New York Department of Health to improve the quality of the water it distributed--chlorinated, but otherwise inadequately filtered--from a village reservoir. Hanover's Lakeshore Hospital and its need for the safe water compounded the urgency of obtaining an alternate supply. A potential outside supplier, the Erie County Water Authority's Sturgeon Point facility, was able to provide fully treated Lake Erie water. But a water transmission main connecting Hanover with this facility would have to extend 13 miles, cross nine protected streams, several highways, and a railroad line. The project required the substantial involvement and support of communities along the proposed route The Authority's charter authorized it to service only customers in Erie County. State legislation amending the original charter had to be secured before the transmission

main could supply neighboring Chatauqua County. Before a legally recognized agreement between the municipalities represented on the board and the Indian Nation could be made, specific legislation permitting the unique relationship had to pass the state legislature. Lacking the ability to raise revenues through taxation, the Seneca Nation had to rely exclusively on federal funding. Before construction could begin, 20 permanent easements and highway, railroad, and creek crossing permits had to be filed. Low bids on the project combined for a price tag of $3.4 million; considerably less than an earlier estimate of $4.2 million. (Chonka-PTT)
W90-09230

BACTERIOLOGICAL QUALITY OF RURAL POTABLE WATER.
National Dairy Research Inst., Karnal (India). Div. of Dairy Microbiology.
S. K. Anand, and R. S. Singh.
Indian Journal of Medical Sciences INJMAO, Vol. 42, p 205-208, 1988. 2 tab, 6 ref.

Descriptors: *Coliforms, *India, *Potable water, *Water quality, Chlorination, Enterococci, Microorganisms, Pollutant identification, Water analysis, Water pollution, Water treatment.

To evaluate the hygienic quality of potable water in rural areas surrounding Karnal, India, a total of 101 water samples were collected from 10 villages outside the city. Samples were collected from hand-pumps and storage pots. Analysis was completed within 5 hours of collection. Total viable counts were made using standard pour plate techniques. Coliforms were determined by five tubes, most-probable-number technique and enterococci were detected using KF-Streptococcus agar followed by biochemical characterization of the isolates. Comparatively high total counts for coliforms and enterococci were encountered from water samples coming from storage pots, compared with hand-pump samples. Coliforms were detected in 85% of samples and enterococci were found in 20% of the water samples. Among the coliforms, 32.5% were of fecal type. Treatments such as chlorination at 2 to 4 ppm and boiling for 1 to 2 minutes improved the microbiological quality of water samples. (Mertz-PTT)
W90-09240

CHEMO-DENITRIFICATION OF NITRATE-POLLUTED WATER.
Ghent Rijksuniversiteit (Belgium). Faculteit Landbouwwetenschappen.
K. Van Hecke, O. Van Cleemput, and L. Baert.
Environmental Pollution ENPOEK, Vol. 63, No. 3, p 261-274, 1990. 8 fig, 1 tab, 12 ref.

Descriptors: *Chemical treatment, *Denitrification, *Drinking water, *Nitrates, *Water quality, *Water treatment, Ammonium, Chemical reagents, Hydrogen ion concentration, Nitrogen compounds, Separation techniques, Water pollution, Water quality standards.

Since the national governments of industrialized countries sharpened their regulations on the nitrate content in drinking water, increasing nitrate concentrations in groundwater and surface water have often led to the legal norms being exceeded. Considerable efforts have already been made in preventive actions, but since it is impossible to reduce the nitrate level in polluted grounwater or surface water within a short period of time, the development and the application of nitrate elimination techniques become inevitable. Nitrate-nitrogen reduction was studied in the presence of ferrous iron and a copper catalyst. In a batch system, it was found that the reduction was very fast at pH 8.1 and slow at pH 7.5. A temporary accumulation of nitrite and hydroxylamine was noted. It was found that the reduction of nitrate-nitrogen in the presence of ferrous iron partly continued to ammonium. Decreasing the amount of reagents led to a slower reduction rate but a lower accumulation of nitrite and hydroxylamine. A continuous system for removal of more than 50% of the initial nitrate involved separation of the treated water from the Fe/Ca suspension by sintered glass filters. Nitrate-

nitrogen can be chemically reduced and of the reaction products, only ammonium poses problems. (Author's abstract)
W90-09270

WATER FLUORIDE CONCENTRATION AND FRACTURE OF THE PROXIMAL FEMUR.
Medical Research Council, Southampton (England). Environmental Epidemiology Unit.
C. Cooper, C. Wickham, R. F. Lacey, and D. J. P. Barker.
Journal of Epidemiology and Community Health JECHDR, Vol. 44, No. 1, p 17-19, March 1990. 2 fig, 15 ref, 1 append.

Descriptors: *Drinking water, *Epidemiology, *Fluoridation, *Fluorides, *Hip fracture, *Public health, England, Hospitals, Statistical analysis, Wales.

The relationship between water fluoride concentration and the incidence of hip fracture was examined in 39 county districts in England and Wales. Numbers of hospital admissions for fractures of the proximal femur were obtained from hospital activity analysis data for the years 1978-1982. The fracture rates were compared with water fluoride concentrations in 39 county districts in England and Wales (fluoride concentrations had been measured in these districts between 1969 and 1973 as part of the British Regional Heart Study). During the study period, 4121 men and 16,272 women aged 45 years and over were discharged from hospital after hip fracture. Poor correlations were found between discharge rates for hip fracture and both total ($r=0.16$, $p=0.34$) and natural ($r=0.01$, $p=0.95$) water fluoride concentrations. Water fluoridation to levels of around 1 mg/L is unlikely to reduce hip fracture incidence markedly in this country. (Author's abstract)
W90-09281

INFLUENCE OF CASING MATERIALS ON TRACE-LEVEL CHEMICALS IN WELL WATER.
Cold Regions Research and Engineering Lab., Hanover, NH.
For primary bibliographic entry see Field 5B.
W90-09316

EVALUATION OF POTASSIUM PERMANGANATE FOR INACTIVATION OF BACTERIOPHAGE MS-2 IN WATER SYSTEMS.
Arizona Univ., Tucson. Dept. of Nutrition and Food Science.
M. T. Yahya, L. K. Landeen, N. R. Forsthoefel, K. Kujawa, and C. P. Gerba.
Journal of Environmental Science and Health (A) JESEDU, Vol. 24, No. 8, p 979-989, 1989. 3 tab, 4 fig, 8 ref.

Descriptors: *Bacteriophage, *Disinfection, *Potassium permanganate, *Viruses, *Water treatment, Chlorination, Hydrogen ion concentration, Oxidants, Regulations.

Potassium permanganate (KMnO4) has been used as an oxidant for decades to remove and control iron and manganese in surface water supplies. This oxidant was investigated for its ability to inactivate bacteriophage MS-2 and thereby reduce the amount of chlorine required for a 99.9% reduction of virus during drinking water treatment as required by the U.S. Environmental Protection Agency's Surface Treatment Rule. Experiments were conducted in potassium monophosphate buffer (pH 6.0 and pH 8.0) at 7 C. At time intervals from 0 to 30 min, samples were taken and mixed immediately with a solution of sodium thiosulfate:sodium thioglycolate to neutralize residual KMnO4. At 0.5 and 5.0 mg/L KMnO4, results showed no significant differences ($p < $ or $ = 0.05$) in the inactivation of MS-2 between experiments done at pH 6.0 and those at pH 8.0. Ninety-nine percent of the virus was inactivated after 50, 35, and 5 min of exposure time to 0.5, 1.5, and 5.0 mg/L KMnO4, respectively. It appears that at the currently used levels of KMnO4 (up to 10 mg/L), this oxidant may supplement high levels of chlorination in the disinfection of water systems. (Author's abstract)

W90-09323

VALUING URBAN WATER ACQUISITION.
Texas A and M Univ., College Station. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6B.
W90-09345

DISTILLATION IRRIGATION: A LOW-ENERGY PROCESS FOR COUPLING WATER PURIFICATION AND DRIP IRRIGATION.
Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 3F.
W90-09365

POTENTIAL FOR REDUCING HUMAN EXPOSURES TO HERBICIDES BY SELECTIVE TREATMENT OF STORM RUNOFF WATER AT MUNICIPAL WATER SUPPLIES.
Heidelberg Coll., Tiffin, OH. Water Quality Lab.
R. P. Richards, and D. B. Baker.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Science Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 127-138, 3 fig, 5 tab, 11 ref.

Descriptors: *Adsorption, *Herbicides, *Public health, *Storm runoff, *Water quality control, *Water treatment, Activated carbon, Costs, Drinking water, Economic aspects, Pesticides, Powdered activated carbon, Water supply.

Rivers draining intensive row-crop agricultural regions may have annual time-weighted mean concentrations of some herbicides which approach or exceed EPA health guidelines for these compounds. Communities which rely on these rivers for drinking water supplies may chose to treat the raw water with powdered activated carbon (PAC) to reduce concentrations in the finished water. Simulation exercises showed that treatment of drinking water supplies with PAC at levels normally used for taste and odor control should be able to reduce pesticide exposures through drinking water substantially. Continuous treatment for three or four months beginning in April or May offered a 40-65% reduction in herbicide mean concentration and is more cost effective than other strategies examined. Treatment with 10 mg/L of PAC is more cost effective than treatment at higher concentrations but leads to smaller reductions in mean concentration. The balance between cost effectiveness and treatment effectiveness can be optimized by adjusting the length of the season during which the treatment is applied. (See also W90-09440) (Author's abstract)
W90-09450

5G. Water Quality Control

BIODEGRADATION OF BTEX IN SUBSURFACE MATERIALS CONTAMINATED WITH GASOLINE: GRANGER, INDIANA.
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 5B.
W90-08678

ENZYMATIC OXIDATION OF SOME SUBSTITUTED PHENOLS AND AROMATIC AMINES, AND THE BEHAVIOR OF SOME PHENOLOXIDASES IN THE PRESENCE OF SOIL RELATED ADSORBENTS.
Bundesgesundheitsamt, Langen (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene.
H. Claus, and Z. Filip.
Water Science and Technology WSTED4, Vol. 22, No. 6, p 69-77, 1990. 2 fig, 7 tab, 6 ref.

Descriptors: *Chemical treatment, *Cleanup operations, *Enzymes, *Phenols, *Soil contamination, *Water pollution treatment, Adsorption, Hydrogen ion concentration, Isoelectric point, Laccases, Peroxidases, Tyrosinases.

When considering phenoloxidases as agents in treating chemical pollution in soil and groundwater environments, possible effects of the specific soil constituents and environmental factors on these enzymes should be investigated. In in vitro experiments, various aromatic amines and alkyl or halogen substituted phenols were oxidized by a laccase, a peroxidase, and a tyrosinase. Oxidation of the latter compounds was accompanied by partial dehalogenation. However, the activity of phenoloxidases was differently inhibited by the presence of clays and clay-humus complexes. Phenoloxidases adsorbed on clays and clay-humus complexes partly lose their activity, with the highest adsorption occurring at pH values near to the isoelectric point of the enzymes and correlating positively with the cation exchange concentration of the clays. Also, pH and temperature exerted different effects on the phenoloxidases. Laccases were active between pH 2.0 and 10, with an optimum between pH 5.0 and 6.0. Peroxidase was strongly inactivated at pH < 4.0 but its activity remained nearly constant above pH 4.0. The tyrosinase stability ranged from 4.0 to 10. When kept for 14 days at 4 C and the optimum pH, laccases showed no activity losses, whereas other phenoloxidases under test retained only about 70% of their original activity. All preparations of phenoloxidases and especially the tyrosinases were more stable in native or autoclaved groundwater at 10 C than in distilled water. (Brunone-PTT)
W90-08680

CHANGE TO A DIATOM ASSEMBLAGE IN A EUTROPHIC LAKE FOLLOWING POINT SOURCE NUTRIENT RE-DIRECTION: A PALAEOLIMNOLOGICAL APPROACH.
University Coll., London (England). Palaeoecology Research Unit.
N. J. Anderson, B. Rippey, and A. C. Stevenson.
Freshwater Biology FWBLAB, Vol. 23, No. 2, p 205-217, April 1990. 6 fig, 57 ref.

Descriptors: *Diatoms, *Eutrophic lakes, *Eutrophication, *Ireland, *Lake restoration, *Paleolimnology, *Phytoplankton, *Water pollution effects, *Water pollution prevention, Chlorophyll, Cores, Food-processing wastes, Nutrients, Phosphorus, Species composition, Statistical analysis, Wastewater pollution.

Lough Augher, County Tyrone, Northern Ireland, underwent eutrophication as a result of untreated effluent disposal by a local creamery, from 1900 until 1972-73, when primary sewage treatment began. When this remedial action met with limited success, the effluent was redirected to the River Blackwater, downstream from the lake. A sediment core taken in July 1981 shows an unambiguous record of the diatom response to this eutrophication; the species succession represents a clear eutrophication gradient, with a shift from mesotrophic plankton forms to a variety of small Stephanodiscus species typical of very eutrophic conditions. The succession is in reasonable agreement with that predicted by changing Si:P ratios. A second, short core, taken in September 1985, shows dramatic changes in the diatom plankton after 1981, with resurgences and rapid increases of species present early in the lake's eutrophication, and representative of mesotrophic conditions. There is clear agreement between the biostratigraphic record of the two cores, for the time period during which they overlap, 1970-81. The available chemical data post-dates the redirection of the creamery effluent. However, it indicates that the phosphorus concentration is in equilibrium with the loading, and has stabilized following effluent redirection. There were no significant differences for chlorophyll a and total phosphorus between the years for which data are available. A Correspondence Analysis Joint-plot was used to summarize the biostratigraphy of the two cores. It serves as an ecological summary of the responses of the plankton diatoms to changing nutrient concentrations and ratios, following the redirection of the creamery effluent, and demonstrates clearly the new direction taken by the planktonic diatoms. Although the phosphorus and chlorophyll a data suggest that the lake returned quickly to an equilibrium state, the diatom community continued to change, suggest-

ing a time-lag effect and non-equilibrium responses by the planktonic diatoms to their nutrient environment. (Author's abstract)
W90-08699

RE-OCCURRENCE OF FILAMENTOUS PLANKTONIC CYANOBACTERIA DURING PERMANENT ARTIFICIAL DESTRATIFICATION.
Fraunhofer-Inst. fuer Umweltchemie und Oekotoxikologie, Schmallenberg (Germany, F.R.).
For primary bibliographic entry see Field 2H.
W90-08714

HAZARDOUS WASTE MINIMIZATION HANDBOOK.
T. E. Higgins.
Lewis Publishers, Inc., Chelsea, Michigan. 1989. 228p.

Descriptors: *Handbooks, *Hazardous wastes, *Industrial wastes, *Waste disposal, *Waste management, *Waste treatment, Case studies, Costs, Economic aspects, Industrial wastewater, Metal-finishing wastes, Toxicity, Waste recovery.

Designed to assist industrial engineers and managers in making changes in purchasing, manufacturing, and waste handling practices to reduce the costs and liabilities of waste disposal, this book begins by defining waste minimization in the first two chapters. Chapters 3 through 7 describe specific waste reduction techniques applied by a number of industries. The chapters in this section have been organized around industrial processes (i.e., painting, metal finishing, machining) rather than around standard industrial classifications (i.e., automotive, chemicals). Industrial processes selected for inclusion are those that are commonly employed in many of the industrial sectors and that contribute the greatest volumes of hazardous waste at a typical facility: machining, cleaning, plating and surface finishing, paint and coating application, and paint and coating removal. These processes and the types of waste produced by each are discussed. Methods used to reduce waste generation are described and illustrated with case studies. Sources of equipment, design data, and installation and operating costs are provided. The book concludes with treatment methods that can be employed to reduce the volume or toxicity of waste, thus further reducing the costs of disposal. (Lantz-PTT)
W90-08749

GROUNDWATER REMEDIATION AND PETROLEUM: A GUIDE FOR UNDERGROUND STORAGE TANKS.
Camp, Dresser and McKee, Inc., Boston, MA.
D. C. Noonan, and J. T. Curtis.
Lewis Publishers, Inc., Chelsea, Michigan. 1990. 142p.

Descriptors: *Cleanup operations, *Gasoline, *Groundwater pollution, *Oil pollution, *Underground storage tanks, Adsorption, Benzene, Biological treatment, Bioremediation, Carbon, Hydrocarbons, Long-term planning, Site remediation, Toluene, Volatile organic compounds, Volatility, Xylenes.

Gasoline is a complex mixture of hydrocarbons, principally comprised of alkane, alkene, and aromatic hydrocarbons. Gasoline spilled or leaked into soil volatilizes due to its high vapor pressure, filling pore spaces with its vapors. Cleaning up a release from an underground storage tank requires both short-term emergency measures and long-term corrective actions. Short-term emergency measures involve taking immediate steps to abate imminent safety and health hazards, including potential explosions. The focus of this book is on long-term remediation and site restoration. Through the use of widely applied and proven technologies, ones that could be recommended at a site to secure desired results. In addition, the technologies are described with a specific focus on removing gasoline from the subsurface, especially the major constituents of concern in gasoline: benzene, toluene, and xylene. The book is structured

as follows: Chapter 2 describes how packed air towers, carbon adsorption systems, and biorestoration techniques remove petroleum hydrocarbons from groundwater. Chapter 3 provides a detailed example problem on designing a packed air tower. Finally, Appendix A summarizes the recently enacted federal regulations governing underground storage tank systems. (Lantz-PTT)
W90-08752

MICROBIOLOGY OF SUBSURFACE ENVIRONMENT: PRELIMINARY STATEMENT OF RESEARCH GOALS AND ABSTRACTS OF CURRENT RESEARCH.
Department of Energy, Washington, DC. Office of Health and Environmental Research.
Department of Energy Report DOE/ER-0278, June 1986. 13p, append.

Descriptors: *Geohydrology, *Groundwater, *Groundwater pollution, *Microbiological studies, *Research priorities, *Savannah River Plant, *Soil organisms, Aquifers, Biological studies, Decontamination, Geochemistry, Groundwater quality, Microorganisms, Project planning.

The Department of Energy (DOE) is working with Savannah River Laboratory/DOE Defense Programs to characterize the presence and abundance of microorganisms, to determine their community structure, and to evaluate the geohydrologic, geochemical, and other factors that control microbial habitats at depth. DOE has chosen to concentrate on the deep, subsurface biosphere for several reasons: (1) fundamental scientific information about microorganisms at depths of 30 to thousands of meters is nonexistent and significant opportunities exist for scientific progress on a national scale; (2) 100 million people rely on groundwater as a drinking water source and many of the Nation's largest aquifers--currently serving large population centers and important to future energy production--are deep aquifers; and (3) deep, inaccessible subsurface systems pose serious long-term restoration challenges because of contamination associated with energy and defense production activities. Biotechnological solutions to deep aquifer contamination in the next decade will depend on such a sound, fundamental scientific information base. These considerations motivate the research. A two phased research program is planned. Phase I (FY86-FY87) is an exploratory phase that focuses on the presence, abundance, and diversity of indigenous microorganisms, on community structure, and on the geohydrologic, geochemical, and physical interactions that control microbial habitats in the subsurface. Phase II (FY88-FY92) will concentrate on exploiting some of the scientific advances and research opportunities identified in Phase I, largely by extended (36-48 month) research investigations. The functioning of microorganisms at depth, biotransformation processes, and community growth rates are among the many areas that may be investigated. Phase II is expected to lead to the mitigation of subsurface contamination, to determining the kinds of environmental stimulation that will contribute to mitigation, and (in time) to evaluation of the impact of bioengineered organisms released to subsurface ecosystems. (Lantz-PTT)
W90-08753

CONSIDERATIONS FOR REDUCING THE COST OF TESTING DREDGED MATERIAL.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5E.
W90-08755

PROTECTING NONTIDAL WETLANDS.
Maryland Dept. of Natural Resources, Annapolis. Nontidal Wetlands Div.
For primary bibliographic entry see Field 2H.
W90-08757

CHESAPEAKE EXECUTIVE COUNCIL, FIRST PROGRESS REPORT UNDER THE 1987 CHESAPEAKE BAY AGREEMENT.
Environmental Protection Agency, Annapolis,

MD. Chesapeake Bay Program.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-206957. Price codes: A03 in paper copy, A01 in microfiche. January 1989. 31p.

Descriptors: *Chesapeake Bay Agreement, *Environmental protection, *Federal jurisdiction, *Interagency cooperation, *Interstate compacts, *State jurisdiction, *Water quality control, District of Columbia, Geographic information systems, Maryland, Model studies, Monitoring, Nutrients, Pennsylvania, Susquehanna River, Virginia, Watershed protection.

Integrated State and Federal efforts achieved substantial progress in 1987-88 toward the goals of the Chesapeake Bay restoration and protection program, including the signing of a new Bay Agreement in December 1987 that promised accelerated advances in the years ahead. Along with development of the more comprehensive Agreement, there has been continued progress in the implementation of restoration activities throughout the watershed since the start of 1987. In addition to ongoing improvements in wastewater treatment facilities in the Bay basin, Pennsylvania, Maryland and Virginia, have expanded efforts to reduce levels of nutrients and sediment reaching the Bay. Conservation practices in the watershed reduced the amount of nitrogen entering the Bay by 7,679 tons in FY87. Reductions of phosphorus amounted to 1,564 tons. The Chesapeake Bay Monitoring Subcommittee produced its second annual 'State of the Chesapeake Bay' report summarizing data collected at 167 stations Baywide from June 1984 through September 1985. Development of the Steady-State Water Quality Model of the Bay and major tributaries was completed in March 1987, enabling Bay managers to evaluate the effects of various nutrient levels and project the results of control options. The Bay Program gained another powerful analytic tool with acquisition of the ARC/INFO geographic system (GIS) in autumn 1987. GIS provides the capability to display spatial data in a variety of ways showing the complex relationships among various environmental elements. The District of Columbia, Maryland and Virginia have passed legislation to protect striped bass. Maryland and Virginia continued working to rebuild striped bass populations. Pennsylvania expanded efforts to promote the restoration of shad in the Susquehanna River, once a prime spawning ground for the species. Virginia enacted the Chesapeake Bay Preservation Act to help promote land use practice intended to protect Bay water quality. Effective July 1, 1988, the law calls for development of criteria for use by local governments in designating preservation areas, such as wetlands and sensitive shorelines, that merit special protection. Maryland continued implementation of its Critical Areas Program to control shoreline development. (Lantz-PTT)
W90-08760

KANAWHA RIVER BASIN WATER QUALITY MODELING.
Hydrologic Engineering Center, Davis, CA.
R. G. Willey.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A203 686. Price codes: A04 in paper copy, A01 in microfiche. Special Projects Report No. 86-5, July 1986. 166p, 2 fig, 8 tab, 20 ref, 4 append.

Descriptors: *Dam effects, *Kanawha River Basin, *Model studies, *Reservoir operation, *Water pollution control, *Water quality, *Water quality management, Dissolved oxygen, Elk River, Flood control, Gauley River, New River, Phytoplankton, Reservoirs, Simulation analysis, Summersville Dam, Sutton Dam, Water temperature.

The purpose of the Kanawha River Basin, West Virginia water quality study was to provide a computer model capable of evaluating water quality conditions that occur throughout the basin during June through September for a given operation of Sutton and Summersville Dams. The HEC-5Q model is capable of simulating the operational effects of as many as ten reservoirs on the

stream network of the basin. Each reservoir may be operated to satisfy a number of objectives including flood control, low flow, hydropower production, water supply and water quality control. The water quality portion of the model will simulate temperature and eight water quality constituents including dissolved oxygen and phytoplankton. The model will internally determine the water quality needed from all reservoir releases to meet specified downstream water quality objectives and will determine the gate openings in each reservoir that will yield the appropriate reservoir release water quality. Should it be necessary, flows will be altered to ensure that downstream water quality objectives are met. The model selects the best solution for system-wide reservoir operation on a daily basis. Better input boundary conditions (i.e., inflow quality to both reservoirs and water quality at Hinton) are needed for improved reproductions in both reservoirs and at all locations in the upper stream reaches of the New, Gauley and Elk Rivers. More water quality data on subbasin inflows would be beneficial in the Clay to Charleston area of the Elk River Basin. In general, data needs exist for all inflowing concentrations. (Lantz-PTT)
W90-08764

IMPROVING STATE OUTREACH TO SMALL COMMUNITIES.
California Univ., Berkeley. Graduate School of Public Policy.
B. L. Livingston.
Available from the National Technical Information Service, Springfield, VA. 22161, PB89-189740. Price codes: A03 in paper copy, A01 in microfiche. Technical Report No. 600/9-89/015, August 1988. 41p, 4 fig, append.

Descriptors: *Governmental interrelationships, *Information exchange, *Public participation, *Public relations, *Rural areas, *State jurisdiction, *Wastewater treatment, Community development, Information transfer, Public access.

Ways to improve outreach to small communities from EPA and the states in wastewater treatment development and maintenance are suggested through the transfer of information, technology, and technical assistance. Outreach can reduce costs and improve performance at relatively low cost. There are five major recommendations to improve outreach: (1) EPA headquarters and region officials could continue coaching states and organizations on improving state outreach programs. EPA could create 'National Organization Outreach Grants' to reach out through state affiliates; (2) the Small Flows Clearinghouse could clarify its audience and develop a new management and funding structure reflecting a constituency of state agencies and national organizations; (3) states could develop 'outreach teams' at the state and regional (substate) level for outreach delivery, advocacy of small community outreach, and to give advice to states; (4) EPA could conduct a national study of how communities within a regional area could pool resources such as credit, insurance, inventory procurement, etc. States could research structural changes in state institutional policies to remove barriers and encourage pooling; and (5) for the sake of efficiency and better communication, integrate small community outreach on wastewater could be integrated with other environmental outreach concerns at EPA, the states and in nonprofit organizations. Funding sources and steps for implementation of each recommendation are included. 'Small Community Ombudsman Offices' to coordinate communications. (Lantz-PTT)
W90-08771

WATER AND EFFLUENT MANAGEMENT IN INDUSTRY: OBTAINING AND USING INFORMATION TO FACILITATE MEANINGFUL DECISION MAKING.
Council for Scientific and Industrial Research, Pretoria (South Africa).
M. R. Steyn.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-176812. Price codes: E07 in paper copy, E07 in microfiche. Technical Digest-12, 1987. 114p, 5 ref.

Descriptors: *Cost analysis, *Costs, *Data acquisition, *Industrial wastewater, *Wastewater management, *Water conservation, *Water pollution control, *Water quality control, Dairy industry, Economic aspects, Food-processing wastes, Industrial water, Metal-finishing wastes, Recycling, Textile mill wastes, Waste recovery, Water reuse.

In management of water and effluent streams, the aim should be to reduce the need to make decisions based on speculations. An abundant supply of information is essential for proper control and management. A water and effluent management control authority must be established within the factory complex. Since problems of water supply and pollution control are common to all departments, this control body must be vested with the necessary power to coordinate the efforts of all sections within a factory complex in order to achieve optimum results. Real water quality requirements need to be evaluated for each process within the factory, along with ways and means to reduce the water consumption by water conservation and water reclamation measures. Every effort must be made to modify processes or equipment in order to prevent objectionable materials from entering the plant effluent. Methods need to be developed to reclaim these materials for reuse in the manufacturing process, and a training program must be established to make everyone involved in plant operation, water and pollution conscious. In the electroplating industry, the following must be done to minimize pollution costs: prevent contamination of plating baths; prevent accidental wastage of process solutions; minimize drag-out losses; reduce rinse water requirements; recover plating solutions; and treat wastes effectively. Pollution cost minimization can be accomplished in the textile industry by: reducing chemical consumption by better process control; substituting chemicals of low pollution load for chemicals of high pollution load; recovering chemicals where possible; reducing pollution load by clean housekeeping methods; segregating inorganic waste flows from the remaining effluent; reducing effluent volume; enforcing segregation and forced evaporation of concentrated sodium wastes; and purifying effluent by chemical precipitation and by biological treatment as applicable. Milk processing industry pollution costs can be minimized by: recovering by-products where possible; segregating drain systems; separating and recovering fat; irrigating fat-free effluent onto pastures; reclaiming and recirculating cooling water for tinned and bottled products; and using automatic shut-off valves on water hoses. (Lantz-PTT)
W90-08772

DESIGN, PLACEMENT, AND SAMPLING OF GROUNDWATER MONITORING WELLS FOR THE MANAGEMENT OF HAZARDOUS WASTE DISPOSAL FACILITIES.
Argonne National Lab., IL. Energy and Environmental Systems Div.
S. Y. Tsai.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-009849. Price codes: A03 in paper copy, A01 in microfiche. Report No. CONF-881246--3, September 30, 1988. 11p, 4 fig, 8 ref. DOE Interagency Agreement MIPR 2688.

Descriptors: *Groundwater quality, *Hazardous wastes, *Monitoring wells, *Network design, *Waste disposal, *Water pollution control, *Water pollution prevention, Groundwater pollution, Monitoring, Water pollution sources, Water sampling.

Groundwater monitoring is an important technical requirement in managing hazardous waste disposal facilities. The Resource Conservation and Recovery Act (RCRA) regulations establish a three-stage monitoring program designed to detect, evaluate, and correct groundwater contamination arising from leaks or discharges from hazardous waste management facilities. The first stage of the monitoring program--detection monitoring--is to be implemented before any leakage of hazardous constituents into the groundwater occurs. Early implementation ensures that any subsequent leakage is detected. When groundwater contamination has already occurred, the second stage--compliance

monitoring--is implemented to determine whether groundwater quality criteria have been exceeded. The standard for this determination comprises four principal elements: (1) the hazardous constituents potentially derived from the facility; (2) the concentration limits for each constituent listed in the facility permit; (3) the point of compliance for measuring concentration limits; and (4) the compliance period. If the criteria set forth in the protection standard are exceeded at the compliance point, then the owner/operator must implement the third stage--corrective action. The remedial action plan must remain in effect until groundwater quality meets compliance standards. When establishing a groundwater monitoring plan for hazardous waste disposal facilities, the following steps are essential: (1) review all available background data to become familiar with the site; (2) establish the local aquifer characteristics and the groundwater flow directions; (3) identify potential off-site sources of background groundwater contamination; (4) determine the chemical composition of the waste material to evaluate the potential for its movement within the aquifer; (5) site a sufficient number of wells upgradient of the site to characterize the background groundwater quality; (6) site a sufficient number of wells downgradient of the site to detect any contaminant plume moving off site; (7) select the proper size and composition of well casing and screens; (8) use an approved well design; and (9) maintain well evacuation and sampling techniques both consistently and efficiently. (Lantz-PTT)
W90-08773

SUBSURFACE SCIENCE PROGRAM: DEEP MICROBIOLOGY TRANSITIONAL PROGRAM IMPLEMENTATION PLAN.
Department of Energy, Washington, DC. Div. of Ecological Research.
F. J. Wobber.
Report No. DOE/ER-0431, November 1989. 13p, 6 ref, append.

Descriptors: *Biodegradation, *Geohydrology, *In situ treatment, *Microbiological studies, *Network design, *Project planning, *Research priorities, *Sampling procedures, Chemical properties, Classification, Cleanup operations, Geochemistry, Groundwater quality, Microorganisms, Physical properties, Quantitative analysis, Statistical studies.

The Department of Energy's (DOE) plans to implement exploratory research as part of its Transitional Program within the Office of Energy Research are outlined. The long-term goal of the program is to obtain information that will facilitate bioremediation of contaminated at DOE sites. Research will be conducted to: (1) develop a comparative information base nationally on the microbiology of different geohydrologic systems; and (2) test and refine experimental aseptic microbiological sampling protocols and technologies for general use at DOE sites. DOE will implement the Transitional Program at DOE's Idaho National Engineering Laboratory (INEL) and the Hanford site. Results at the first site will: (1) meet two or more scientific objectives in the Transitional Program Plan (DOE/ER), and (2) provide scientific and technological experience needed to confirm results or meet objectives at the next site. An important goal is to develop a variety of aseptic sampling technologies that can be used to sample the deep subsurface microflora under the varied geohydrologic and geochemical conditions found at DOE sites. Seven principal research activities will be pursued to meet the scientific goals of Transitional Program: Activity 1--characterization of the subsurface microflora; Activity 2--physical and chemical characterization of subsurface samples; Activity 3--evaluation of geohydrochemical controls on subsurface microorganisms; Activity 4--statistical comparison/correlation of data from different sites; Activity 5--development of new drilling, sampling, and sample-handling methodologies; Activity 6--quantification of vertical and spatial variability within the subsurface microflora; and Activity 7--general program support activities. (Lantz-PTT)
W90-08775

143

Group 5G—Water Quality Control

NATIONAL FOREST SYSTEM: AMERICA'S HEADWATERS.
Lolo National Forest, Missoula, MT.
For primary bibliographic entry see Field 6D.
W90-08823

NONPOINT SOURCE POLLUTION MANAGEMENT AND COMPLIANCE WITH REGULATORY MANDATES.
Forest Service, San Francisco, CA. Range and Watershed Management.
J. R. Rector.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 21-29, 4 ref.

Descriptors: *Headwaters hydrology, *Nonpoint pollution sources, *Regulations, *Water pollution control, *Water quality management, Legal aspects, Clean Water Act, Institutional constraints, Legislation, State jurisdiction, Water quality control.

Following completion of water quality management planning and program development, necessitated by the Federal Clean Water Act (CWA), States assume the regulatory role and responsibility for nonpoint source (NPS) pollution control. States are charged with the responsibility of establishing the substantive and procedural requirements that will result in NPS pollution control and attainment of CWA goals and objectives. When nonpoint source pollution reaches the point of enforcement and/or litigation, cases usually center on a question of compliance with water quality regulatory requirements established by state authority(s). NPS pollution is usually derived from nondiscernible and dispersed sources and do not readily lend themselves to the same controls applied to point sources of pollution. NPS afford flexibility in methods to achieve compliance with state requirements due to their unique nature. Three options are available to the potential nonpoint discharger to respond to compliance requirements: (1) take no action to respond, ignoring legal requirements and the need to protect and preserve the Nation's water quality, (2) follow established substantive and procedural requirements as established by the regulatory authority, and (3) participate in ongoing water quality management planning to develop a tailor made management program. Practices are negotiated with regulatory authorities to serve as 'in lieu of' compliance requirements to attain water quality goals and objectives. In litigation, the question of compliance or noncompliance must be guided by counsel from the legislatively established regulatory authority. Court decisions must take into account which of the three options for compliance responsiveness the defendant pursued. The fundamental differences between point and nonpoint pollution are only now beginning to be addressed by the regulating agencies. Viable standards are lacking against which to measure CWA goals and objectives attainment or against which to measure lawful compliance. Negotiated agreements between the regulatory authority and the regulated entity must become an integral part of NPS control programs and decisions regarding compliance with water quality mandates. (See also W90-08822) (Author's abstract)
W90-08825

FEDERAL NONPOINT SOURCE CONTROL EFFORTS--HISTORICAL GAO OBSERVATIONS.
General Accounting Office, Washington, DC.
C. D. Mosher.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 31-39, 14 ref.

Descriptors: *Federal jurisdiction, *Headwaters hydrology, *Nonpoint pollution sources, *Regulations, *Water pollution control, *Water quality management, History, Water quality control.

In 1977 the U.S. General Accounting Office (GAO) published a report on federal nonpoint source (NPS) efforts. It noted at that time that over half of the pollutants entering the nation's waterways were from NPS and that if not con-

trolled, NPS would prevent attainment of national water quality goals. Problems related to federal efforts to control NPS included inadequate water quality data used for planning and assessing water quality improvements and NPS controls, and an over-emphasis on point source controls, with minimal effort on NPS. GAO has issued several subsequent reports on the need for better data for water quality planning and in 1988 published a report on the benefits of riparian area restoration, along with better rangeland controls. The report includes examples of successful riparian restoration efforts on federal lands in 10 western states. In addition, GAO is conducting a new study of federal NPS efforts. Although national in scope, the study covers federal and state NPS practices in several western states. This information should be useful in understanding state and federal NPS control problems and control possibilities for headwaters areas. (See also W90-08822) (Author's abstract)
W90-08826

CUMULATIVE EFFECTS OF HUMAN ACTIVITIES ON BULL TROUT (SALVELINUS CONFLUENTUS) IN THE UPPER FLATHEAD DRAINAGE, MONTANA.
Montana Dept. of Fish, Wildlife and Parks, Kalispell.
For primary bibliographic entry see Field 4C.
W90-08834

AGRICULTURAL MANAGEMENT AND POLICY NEEDS FOR SALINITY ABATEMENT IN EASTERN MONTANA.
Montana Salinity Control Association, Conrad.
S. K. Brown, M. D. Tomer, G. A. Hockett, and J. M. Holzer.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 135-139, 1 fig, 6 ref.

Descriptors: *Agricultural water, *Agricultural watersheds, *Headwaters hydrology, *Salinity, *Soil salinization, *Water pollution control, Agricultural practices, Alfalfa, Environmental policy, Groundwater quality, Groundwater recharge, Management planning, Montana, Saline groundwater.

Salinization of soil and water resources has occurred over portions of the Northern Great Plains during the past 50 years. The degradation is attributable to summer fallow dryland farming practices which replaced native rangeland conditions. Inefficient use of precipitation has allowed deep percolation of soil moisture and migration of soluble salts. Artificial buildup of shallow saline groundwater combined with certain geologic conditions has led to the development of low volume saline springs (saline seeps). Saline ground water and soil contamination can be prevented through intensified cropping which efficiently uses seasonal precipitation. Reclamation techniques include alfalfa and flexible annual cropping rotations in upslope recharge areas. The Teton Ridge near Choteau, MT is an example of a large scale problem area. This watershed discharges saline groundwater (1,500-72,00 mg/L total dissolved solids) to the Teton River and Freezeout Lake Wildlife Refuge. In cases like this, where land ownerships change between the recharge and discharge areas, economic incentives are needed to encourage adoption of intensified cropping. Present farm policy inhibits changes in cropping strategies. Policies that allow more flexibility and encourage crop rotations need to be included in the 1990 farm bill. This would give farmers more leeway in addressing local resource concerns. (See also W90-08822) (Author's abstract)
W90-08837

EFFECTIVENESS OF BMP'S IN CONTROLLING NONPOINT POLLUTION FROM SILVICULTURAL OPERATIONS.
Pennsylvania State Univ., University Park. School of Forest Resources.
J. A. Lynch, and E. S. Corbett.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Associa-

tion, Bethesda, Maryland. 1989. p 149-157, 3 fig, 3 tab.

Descriptors: *Best management practices, *Environmental effects, *Forest watersheds, *Headwaters hydrology, *Nonpoint pollution sources, *Silviculture, *Water pollution control, Clear-cutting, Forestry, Nitrates, Potassium, Turbidity, Water quality.

Ten years of streamflow and water quality data were evaluated to determine the effectiveness of Best Management Practices (BMP's) in controlling nonpoint source pollution from an 110-acre commercial clearcut located in the Ridge and Valley Province of central Pennsylvania. The analyses addressed both short-term and long-term changes in the physical and chemical properties and the hydrologic regime of the stream draining this 257-acre watershed. Overall, the BMP's employed on this commercial clearcut were very effective in preventing serious deterioration of stream quality as a result of forest harvesting. Although significant increases in nitrate and potassium concentrations and temperature and turbidity levels were measured, the increases were relatively small and, with the exception of turbidity, within drinking water standards. Increased turbidity levels were the result of wind thrown trees adjacent to the channel and were not directly related to timber harvesting activities. Nitrate and potassium concentrations and turbidity levels remained above pre-harvesting levels for as long as eight years following harvesting. Clearcutting also significantly increased water yield which in turn lowered the concentrations of some ions because of dilution. Increased water yields returned to pre-harvesting levels within four years as a result of rapid regrowth. The export of some ions increased; however, the increased export appeared to be insufficient to affect site productivity. (See also W90-08822) (Author's abstract)
W90-08839

EDUCATING ABOUT WATER QUALITY ISSUES.
Clemson Univ., SC. Dept. of Agricultural Economics and Rural Sociology.
V. W. House, and D. Yanggen.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 243-247, 2 ref.

Descriptors: *Education, *Headwaters hydrology, *Water quality, Information exchange, Public opinion, Public participation, Public policy.

Water quality is a public issue. Educators who try to educate about issues run the risk of being labeled as partisans. An educational methodology called the 'alternatives-consequences approach' permits educators to stay in their educational role rather than a political one; to deal with controversy without being controversial. The approach is simple but does require the educator to commit him/herself to letting the people decide what is best. The alternatives-consequences approach is a proven methodology that is readily applicable to water quality issues. (See also W90-08822) (Author's abstract)
W90-08847

CLASSIFICATION AND SPATIAL MAPPING OF RIPARIAN HABITAT WITH APPLICATIONS TO MODELING INSTREAM IMPACTS OF AGRICULTURAL NONPOINT SOURCE POLLUTION.
Idaho Univ., Moscow. Dept. of Plant, Soil and Entomological Sciences.
For primary bibliographic entry see Field 5C.
W90-08850

COPE RESEARCH ON RIPARIAN ZONE MANAGEMENT IN THE OREGON COAST RANGE.
Environmental Research Lab.-Narragansett, Newport, OR. Mark O. Hatfield Marine Science Center.
A. E. Skaugset, C. G. Bacon, A. J. Hansen, and T.

E. McMahon.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 277-285, 2 fig.

Descriptors: *Environmental policy, *Environmental protection, *Headwaters hydrology, *Management planning, *Oregon, *Riparian land, *Riparian waters, Research priorities.

In Oregon, riparian zone management is a subject of intense concern and interest. This is especially true in the Oregon Coast Range where riparian zones are important for timber production and as habitat for fish and wildlife. The study of integrated management in riparian areas is a primary focus of a recently formed research and education cooperative called Coastal Oregon Productivity Enhancement, or COPE. The COPE program includes Fundamental or 'basic' research and Adaptive or 'applied' research. Adaptive COPE responsibilities also include a strong education component. Adaptive COPE scientists will be communicating the results of COPE research to cooperators, resource managers, and the public through newsletters, workshops, publications, and one-to-one communication. Fundamental COPE research includes riparian vegetation dynamics, wildlife and fisheries interactions within riparian zones, and buffer strip effectiveness. Adaptive COPE research includes conifer establishment in hardwood dominated riparian zones and the role of large woody debris for fish habitat. These studies will be coordinated in an effort to determine ecological interactions between riparian resources. The objective of the riparian research is to determine resource trade offs of alternative management strategies at the local and watershed-level scale. (See also W90-08822) (Author's abstract)
W90-08851

CONTROL OF ATTACHED ALGAE BY NITROGEN AND PHOSPHORUS IN THE CLARK FORK RIVER.
Montana Univ., Missoula.
For primary bibliographic entry see Field 5C.
W90-08852

OPPORTUNITIES FOR RIPARIAN ECOSYSTEM PRESERVATION IN THE VERDE RIVER BASIN, ARIZONA.
Environmental Defense Fund, Oakland, CA.
D. Moore.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 351-360, 3 fig, 16 ref.

Descriptors: *Ecological effects, *Environmental protection, *Headwaters hydrology, *Riparian waters, *Verde River, *Water depletion, *Water pollution control, Arizona, Case studies, Competing use, Instream flow, Riparian land, Water conservation, Water quality control, Water resources development, Water rights, Water use.

In Arizona, 95% of the riparian habitat has been lost due to impoundments, surface water diversions, groundwater pumping, and land conversions. The Verde River, located in the Gila River basin in central Arizona, provides much of the remaining five percent and its headwaters are home to the threatened native fish species, the spikedace. Yet, the Verde River's precious instream flows are still in danger of being depleted by exchanges of surface water to fulfill Central Arizona Project allocations and increased groundwater pumping to satisfy both local growth and exports. A case study of this region is presented in an effort to identify creative solutions to such problems through the use of conservation and incentive-based mechanisms as alternatives to do more conventional water supply planning approaches. The study examines the desert riparian ecosystem of the Verde River, current water supply and use, and future water supply scenarios that try to resolve conflicts among environmental, rural, Native American and urban interests. Alternatives discussed include investments in water conservation in exchange for rights to the saved water, and acquisition and transfer of senior water rights

to instream uses, considering in each linkages between cumulative impacts and the economic and institutional structures that control water use. (See also W90-08822) (Author's abstract)
W90-08858

FLUME STUDY EXAMINING THE FILTERING EFFICIENCY OF SILT FENCES USING SITE-SPECIFIC SOILS.
Utah Dept. of Natural Resources, Salt Lake City.
Div. of Oil, Gas and Mining.
For primary bibliographic entry see Field 4D.
W90-08866

CUMULATIVE WATERSHED EFFECTS (CWE) ANALYSIS IN FEDERAL AND PRIVATE FORESTS IN CALIFORNIA.
Forest Service, South Lake Tahoe, CA. Lake Tahoe Basin Management Unit.
For primary bibliographic entry see Field 4C.
W90-08867

APPLICATION OF CUMULATIVE WATERSHED EFFECTS (CWE) ANALYSIS ON THE ELDORADO NATIONAL FOREST IN CALIFORNIA.
Forest Service, South Lake Tahoe, CA. Lake Tahoe Basin Management Unit.
For primary bibliographic entry see Field 4C.
W90-08868

BASELINE RISK ASSESSMENT: A CONVINCING CUMULATIVE EFFECTS ANALYSIS IN THE BULL RUN WATERSHED.
Forest Service, Troutdale, OR. Columbia Gorge Ranger District.
For primary bibliographic entry see Field 4D.
W90-08869

PROTECTING THE WET COMMONS.
Scripps Institution of Oceanography, La Jolla, CA.
For primary bibliographic entry see Field 6G.
W90-08940

NITROGEN MANAGEMENT RELATED TO GROUNDWATER QUALITY IN MINNESOTA.
Minnesota Univ., St. Paul. Dept. of Soil Science.
J. L. Anderson, G. L. Malzer, G. W. Randall, and G. W. Rehm.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 53-57, Fall 1989. 2 fig, 5 tab, 14 ref.

Descriptors: *Fate of pollutants, *Fertilizers, *Groundwater pollution, *Minnesota, *Nitrates, *Nitrogen cycle, *Organic nitrogen, *Path of pollutants, *Water pollution prevention, Agricultural chemicals, Nonpoint pollution sources.

In 1987 farmers in Minnesota used more than 0.56 billion kilograms of fertilizer nitrogen (FN), fifth in overall fertilizer nitrogen use in the United States. Nitrogen is essential for crop production, and soils do not supply adequate N for high production. There are concerns, however, about FN use relative to profitability and potential impacts on groundwater. The nitrogen cycle is complex, and is dependent upon many chemical reactions and interaction between FN, soils, and crops. There are many sources and sinks of nitrogen in ecosystems. The goal of an FN management system is to maximize FN uptake and minimize FN leaching. The impact of agricultural management practices on groundwater requires that all sources and fates be considered before FN rates are determined. Research is underway to evaluate relationships between FN application for continuous corn and movement of nitrate through soil profiles. Growers making N management decisions have to be able to evaluate the complex nature of N in the environment when they determine their crop needs. Computer software is under development to provide this information on a site specific basis. (Author's abstract)
W90-08977

COUNTY-BASED PRIORITY ASSESSMENT METHODOLOGY FOR PHASING OF WELLHEAD PROTECTION PROGRAMS.
Minnesota Univ., Minneapolis. Dept. of Geology and Geophysics.
H. O. Pfannkuch, M. E. Campion, D. C. McCaa, and J. M. Palenberg.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 63-70, Fall 1989. 7 fig, 8 ref.

Descriptors: *Minnesota, *Model studies, *Risk assessment, *Statistical models, *Water quality management, *Wells, Geohydrology, Karst.

Setting priorities to schedule and implement wellhead protection programs for municipal and community drinking water supplies is presented in the framework of a general risk assessment approach. This includes a hazard identification procedure representing the likelihood of contaminants being released to the surface environment, a hydrogeologic vulnerability assessment representing the risk of contaminants entering the groundwater supply, and an impact assessment, strongly linked to the population at risk. The county is chosen as the basis for aggregating information, since the county is the basic accounting unit for a wide variety of statistical information such as population, land use, public health data, and others. The resulting composite risk index map shows a number of counties in the central part of the state roughly following a line from the Twin Cities Metropolitan area along two major transportation axes to the St. Cloud and Fargo-Moorhead area, and toward the south to the Rochester-Austin area to which a high priority for phasing-in of the program is recommended. These counties emerge as high priority regions in addition to those in the southeastern karst area of Minnesota that traditionally have been identified as vulnerable areas. (Author's abstract)
W90-08979

REGIONAL NATURE OF LAKE WATER QUALITY ACROSS MINNESOTA: AN ANALYSIS FOR IMPROVING RESOURCE MANAGEMENT.
Minnesota Pollution Control Agency, Roseville.
Div. of Water Quality.
For primary bibliographic entry see Field 2H.
W90-08980

WATER QUALITY AND MANAGEMENT OF LAKES IN THE TWIN CITIES METROPOLITAN AREA.
Metropolitan Council, St. Paul, MN.
R. A. Osgood, and G. L. Oberts.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 78-80, Fall 1989. 19 ref.

Descriptors: *Eutrophic lakes, *Eutrophication, *Lake management, *Land use, *Minnesota, *Phosphorus compounds, *Water pollution effects, *Water pollution treatment, Detention reservoirs, Phosphorus, Ponding, Regional planning, Snowmelt, Storm runoff, Water quality management.

There are 666 lakes of at least 10 hectares in the Twin Cities Metropolitan Area (TCMA), many of which have good water quality. However, there is a slow degradation in the water quality of TCMA lakes due to phosphorus enrichment from external sources. Current watershed practices are not arresting this degradation. While the water quality of the lakes does not appear to limit most uses, nuisances do exist. Commonly-used watershed treatments, such as wetland diversions and ponding, are ineffective at reversing or completely mitigating the degradation following land development. Rainfall events tend to increase the amount of dissolved phosphorus in the outflow from wetlands and detention systems; even though a detention system may register a very good annual performance, there may be serious seasonal impacts on the lakes. Lake managers should reduce the external loading of phosphorus to the greatest possible extent; then, if further water quality improvements are necessary, those measures which treat eutrophication-related symptoms should be considered for the

long-term management of the lakes. (Author's abstract)
W90-08981

LAKE MIXING DYNAMICS AND WATER QUALITY MODELS.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
H. G. Stefan.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 86-94, Fall 1989. 11 fig, 1 tab, 15 ref.

Descriptors: *Lake restoration, *Lakes, *Limnology, *Minnesota, *Model studies, Ammonium, Aquatic plants, Cycling nutrients, Detritus, Dissolved oxygen, Dissolved solids, Lake stratification, Nitrates, Nitrites, Phosphorus, Phytoplankton, Suspended solids, Temperature, Thermal stratification, Water circulation.

Lakes around the world, including some in Minnesota, are showing changes in water quality due to cultural eutrophication, acid rain, and climate change. To forecast water quality changes or to evaluate the potential success of restoration measures in lakes, it is necessary to formulate models which relate lake water quality to the inflows and outflows of materials and energy. Lake water quality is related to dissolved and suspended materials in the inflow, in-lake mixing dynamics, lake water chemistry, in-lake biological species and processes, and outflow rates. Important concepts of dynamic deterministic (cause-effect) models include the physical characteristics of thermal hydrodynamics, and the biological influence of plant growth and nutrient kinetics. Thermal hydrodynamics in lakes are characterized by water movements that are very slow, and the driving forces are small density gradients caused by temperature differences and dissolved or suspended substances. Phytoplankton kinetics are related to the nitrogen and phosphorus cycles, dissolved oxygen balance, and food chain response. Realistic deterministic simulation models for Minnesota lakes are one-dimensional and simulate changes in the depth profile of temperature, chlorophyll a, biologically available phosphorus, cellular phosphorus, detritus and detrital phosphorus, dissolved oxygen, and suspended and dissolved solids with optional simulation of nitrate, nitrite, and ammonium. Dynamic modeling can be used to evaluate key water quality parameters and can be used to select in-lake restoration techniques. (Tappert-PTT)
W90-08983

METROPOLITAN WASTEWATER TREATMENT PLANT AND THE MISSISSIPPI RIVER: 50 YEARS OF IMPROVING WATER QUALITY.
Metropolitan Waste Control Commission, St. Paul, MN.
For primary bibliographic entry see Field 5D.
W90-08990

EARTHDAY 1990: A BENCHMARK FOR ASSESSING WATER QUALITY.
Camp, Dresser and McKee, Inc., Maitland, FL.
A. W. Saarinen.
Water Environment & Technology WAETEJ, Vol. 2, No. 4, p 36-39, April 1990.

Descriptors: *Legal aspects, *Water pollution effects, *Water quality management, *Water quality standards, Public policy.

Earthday 1990 is an appropriate time to reflect on water quality by reviewing the accomplishments of the last 20 years, as well as looking forward to the challenges of the future. In 1969, the public did not seem to care about polluted rivers and environmental protection. Millions of gallons of untreated wastewater were discharged into water bodies each day. Public perception of water quality reached its nadir on June 22, 1969, when the Cuyahoga River in Ohio made national headlines after it literally caught fire. Earth Day 1970 became the largest organized demonstration in history, with an estimated 25 million Americans participating in events throughout the country. Just 80 days after the first Earth Day, the United States

Environmental Protection Agency was created. The Clean Water Act followed in 1972. There is visible evidence of the progress that has been made in cleaning up water pollution and improving water quality. Lake Erie, doomed to death in the 1950s, is alive and well. The Cuyahoga River has been restored, and countless other rivers and streams throughout the country are impressive examples of the successes in cleaning up polluted waterways. Challenges remaining include nonpoint sources and toxic chemicals, both from direct municipal and industrial discharges and nonpoint sources. Institutional challenges include obtaining sufficient funding to meet the requirements of the Clean Water Act and to pay for new requirements. Success depends upon adopting a steward's ethic towards the environment and taking a personal role by recycling, limiting the use of fertilizers, and other environmentally oriented actions. (Tappert-PTT)
W90-08999

MANAGEMENT OF THE RIVER RHINE.
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
J. de Long.
Water Environment & Technology WAETEJ, Vol. 2, No. 4, p 44-51, April 1990. 2 tab.

Descriptors: *Eutrophication, *Governmental interrelations, *Rhine River, *Water pollution control, *Water pollution effects, *Water pollution treatment, *Water quality management, Agricultural chemicals, Algal blooms, Fishkill, Groundwater pollution, Nitrates, Nonpoint pollution sources, North Sea, Nutrients, Phosphates, Wastewater pollution.

River management in Europe is a complex process involving many aspects of legislation and policy-making and land use by man. The Rhine River has a long history of international management because of its location in a densely populated and highly industrialized part of Europe. Within the last few decades, the river's pollution has increased tremendously, and the quality of the river's ecosystem has deteriorated. Because of efforts in the countries bordering the Rhine, improvements have been realized during the past decade. Major organic pollution began when the cities along the river developed wastewater systems. Organic pollution, sometimes causing extensive fish kills, increased until the beginning of the 1970s, when biological wastewater treatment started. Metals have been a problem in the past, although there seems to be some improvement recently. Nutrient concentrations have increased dramatically, primarily from agricultural origins. Groundwater in the Rhine catchment area is becoming increasingly polluted with chemicals such as nitrate and pesticides. The river has suffered a decline in species diversity, and nutrient discharges into the North Sea have led to algal blooms. The International Rhine Commission, formed after the Second World War, agreed to a Rhine Action Programme in 1986 that focusses on three goals: (1) to guarantee the production of drinking water from the Rhine in future years; (2) to reduce sediment pollution in the Rhine; and (3) to improve the ecosystem of the Rhine so that higher species such as the salmon may again become indigenous. This is the first step towards an integrated approach and to decision-making on an international level within the European community. (Tappert-PTT)
W90-09000

PERSPECTIVE ON BIOLOGICAL ASSESSMENTS.
Monsanto Co., St. Louis, MO.
D. R. Grothe, R. A. Kimerle, and C. D. Malloch.
Water Environment & Technology WAETEJ, Vol. 2, No. 4, p 62-67, April 1990. 3 fig, 2 tab.

Descriptors: *Biological studies, *Ecosystems, *Toxicity, *Toxicology, *Wastewater disposal, *Wastewater pollution, *Water pollution control, *Water quality control, Industrial wastewater, Legal aspects, Wastewater treatment.

In 1984 the United States Environmental Protection Agency issued new policies governing the

way in which wastewater discharges would be evaluated. The program, implemented through the National Pollutant Discharge Elimination System (NPDES), required site-specific, water quality-based toxicological assessments to control toxic chemicals found in wastewaters. In essence, this meant that the aquatic safety of a wastewater would be interpreted in relation to wastewater toxicological data and projected receiving-water exposure concentrations. Monsanto has performed effluent toxicity tests for ten years, developed procedures for assessing effluent safety, and negotiated NPDES toxicity testing requirements. Monsanto has developed a three-tier description of wastewater safety, depending upon the margin of safety between the biological effect and the environmental exposure concentrations; (1) apparently safe, because of a larger margin of safety; (2) apparently unsafe, because the exposure concentration is higher that the concentration estimated to adversely impact the ecosystems and exposure must be reduced; and (3) additional tier data is needed to resolve the marginal difference between exposure and effects. There are concerns over toxicity data uncertainty, toxicity test precision, and the techniques used to perform toxicity reduction evaluations. Recognizing that biological assessments are now an integral part of the NPDES toxics control program, it is important that the scientific and regulatory communities use scientifically sound and reproducible approaches to evaluate effluent safety. (Tappert-PTT)
W90-09003

SYSTEMS APPROACH TO DRAINAGE REDUCTION IN THE SAN JOAQUIN VALLEY.
California Univ., Davis. Dept. of Land, Air and Water Resources.
B. R. Hanson.
Agricultural Water Management AWMADF, Vol. 16, No. 1/2, p 97-108, August 1989. 2 fig, 28 ref.

Descriptors: *California, *Drainage water, *Irrigation effects, *Irrigation engineering, *San Joaquin Valley, *Subsurface drainage, *Water pollution control, Management planning, Regional analysis, Saline water, Water table management.

The subsurface drainage problems of the San Joaquin Valley of California require that substantial drainage reduction be achieved through irrigation and drainage water management. Drainage reduction in the valley must be a systems approach in which all components of water management are considered. These components include irrigation system design and operation, irrigation scheduling, drain water use for crop production, and leaching/drainage. Keys to drainage reduction through irrigation water management are improving the uniformity of the applied water and reducing the average depth applied. Uniformity can be improved by upgrading existing surface irrigation systems or converting to sprinkler or drip/trickle systems. The average depth applied can be reduced by improving irrigation water management, such as reduced set times and better irrigation scheduling. Drain water use for crop production also can reduce subsurface drainage. Strategies for drain water use include irrigation with saline water and water table management. However, the leaching/drainage requirements must be considered when implementing these strategies. (Author's abstract)
W90-09012

LAND USE CHANGES AND INPUTS OF NITROGEN TO LOCH LEVEN, SCOTLAND: A DESK STUDY.
Edinburgh School of Agriculture (Scotland).
For primary bibliographic entry see Field 4C.
W90-09014

IRRIGATION WATER PRICING POLICIES TO REDUCE AND FINANCE SUBSURFACE DRAINAGE DISPOSAL.
Hebrew Univ. of Jerusalem, Rehovoth (Israel). Faculty of Agriculture.
For primary bibliographic entry see Field 3F.
W90-09016

GROUND WATER CONTAMINATION: SOURCES, EFFECTS AND OPTIONS TO DEAL WITH THE PROBLEM.
For primary bibliographic entry see Field 5B.
W90-09063

BASIS FOR ACTION.
J. A. Cotruvo.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 47-57.

Descriptors: *Epidemiology, *Groundwater pollution, *Groundwater quality, *Public health, *Regulations, *Water pollution control, *Water pollution effects, Cost-benefit analysis, Decision making, Dose-response relationships, Economic aspects, Environmental protection, Feasibility studies, Risk assessment, Safe Drinking Water Act, Toxicology, Water quality standards.

Public health and environmental protection actions are often a question of what is safe and how one decides what is safe. Health protection is the principal determinant in establishing any environmental regulation. In the face of uncertainty, and a variety of population sensitivities and exposures, many conservative assumptions are made when making judgments in a regulatory context. The great dilemma in toxicology is the existence of the non-threshold assumption in cases of substances that may be carcinogenic. The traditional toxicological approach is to assume that there are concentration thresholds for adverse effects for almost any harmful substance. On the non-threshold side, it is assumed that there is some theoretical, quantifiable risk that is associated with exposures to certain kinds of substances. The possibility of non-threshold mechanisms of toxicity leaves the impossible dilemma of having to regulate always in the context of possible residual risk and of residual harm at any level above zero, and zero dose usually is not achievable. There are cost/benefit balancing statutes that require the compilation of quantified costs and benefits of a regulation, to decide where the balance point is and regulate where the benefits exceed the costs. There are unreasonable risk statutes which require the EPA to decide what is a reasonable or an unreasonable risk. The Safe Drinking Water Act (SDWA) has a very different underlying premise. It says that water quality goals should be established at levels at which there are no known or anticipated adverse effects from the consumption of water. SDWA also requires a separate determination of the legally enforceable standard, to be determined on the basis of feasibility, costs, and engineering factors. In essence, the regulatory ground rules are established by the law and science plays an essential role in them; economics and feasibility are the ultimate deciding factors. (See also W90-09063) (Fish-PTT)
W90-09065

RISK ASSESSMENT AS A BASIS FOR ACTION.
R. Hartung.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 59-65, 5 ref.

Descriptors: *Epidemiology, *Groundwater pollution, *Groundwater quality, *Public health, *Risk assessment, *Water pollution control, *Water pollution effects, *Water quality standards, Carcinogens, Detection limits, Dose-response relationships, Environmental effects, Environmental protection, Standards.

There are many locations where groundwater has been, and is being, contaminated because of human activities. It is possible to minimize the contamination of groundwater by controlling acts arising from ignorance or negligence. The concept of 'contamination' as a basis for action is not without problems. Absolute purity is primarily a philosoph-

ical concept, and 'pure' water does not exist, not even as a laboratory curiosity. Groundwater contamination by humans tends to be defined on the basis of the analytical detection limit for easily detectable and relatively stable synthetic compounds, such as trichloroethylene or tetrachloroethylene. Using contamination as a benchmark for action has the advantage of simplicity and directness. However, the price to be paid for its use is that it is based on many absolute concepts which are difficult to deal with in actual situations. In addition, contamination is not necessarily related to the potential for adverse effects. The concept of 'risk assessment' is replete with complexities. Risk assessment deals directly with the need to protect against potential adversity. But in the process of deriving risk assessments, the uncertainties inherent in this approach become very obvious, and tend to make direct action more difficult. Human health effects are considered under two very different rubrics with different methodologies: (1) non-carcinogens are considered to have thresholds, and the lower plausible limits of those thresholds are estimated on the basis of uncertainty and safety factors applied to experimental data; and (2) carcinogens are usually considered to have no thresholds, and therefore any dose is estimated to be associated with a risk. Actions based on risk assessment may be complex, but they seek to address the potential for the occurrence of adverse effects. Risk assessments for the protection of groundwater resources should not be based exclusively on potential health effects, but should also be based upon potential ecosystem effects. (See also W90-09063) (Fish-PTT)
W90-09066

HOW SHOULD GROUND WATER HEALTH STANDARDS BE SET. POSSIBLE APPROACHES TO STANDARDS SETTING.
G. V. Cox.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 67-95, 73 ref, append.

Descriptors: *Epidemiology, *Groundwater pollution, *Groundwater quality, *Public health, *Regulations, *Water pollution control, *Water pollution effects, *Water quality standards, Carcinogens, Detection limits, Dose-response relationships, Environmental protection, Model studies, Risk assessment, Safe Drinking Water Act.

The public would like to have zero as an acceptable level of contamination and of risk, but this is impossible. Setting Recommended Maximum Concentration Levels (RMCLs) for carcinogens at zero or at the analytical detection limit is impractical, unworkable, and unwise, and would give rise to a variety of undesirable consequences outside the context of the Safe Drinking Water Act. Risk assessment must not be permitted to deteriorate into an exercise of simple statistical modeling. Rather, qualitative considerations should play a critical role in evaluating the quantitative information and deciding how it should be interpreted and used to develop a resulting estimate of risk. The relationship between the administered dose and the effective or delivered dose deserves close scrutiny; it is important to determine the quantity of the biologically effective dose that reaches the actual target site. Risk models used should not be restricted to non-threshold, linear models. Finally, an appropriate use of quantitative risk assessment to set RMCLs must clearly distinguish between the risk assessment and risk management functions. Risk levels used to trigger regulatory action, as well as those deemed acceptable after regulatory action has been taken, vary both within EPA and among other federal agencies. Health standards for carcinogenicity could be set by applying an appropriate safety/uncertainty factor to an 'apparently safe level' on the basis of epidemiological studies or animal bioassays. (See also W90-09063) (Fish-PTT)
W90-09067

GROUND WATER CLEANUPS AND STANDARDS.

For primary bibliographic entry see Field 2F.
W90-09070

HOW CLEAN IS CLEAN: A FIELD PERSPECTIVE.
W. P. Moore.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 217-223.

Descriptors: *Groundwater pollution, *Groundwater quality, *Legislation, *Management planning, *Water pollution control, *Water quality management, California, Clean Water Act, Environmental protection, Permits, Resource Conservation and Recovery Act, Risk assessment, Site remediation, Superfund, Toxic Substances Control Act, Water quality standards.

There are four pieces of legislation (Clean Water Act, Resource Conservation and Recovery Act, Superfund, and Toxic Substances Control Act) that treat groundwater control, each in a different manner and not in its entirety. Risk assessment has five elements: the different environmental media involved, the duration of exposure, derivation of acceptable daily human dose, how to treat carcinogens versus noncarcinogens, and multichemical effects. California, following the classic method, has the looks at risk for three different degrees of remediation: a no-action level, an intermediate remediation, and finally a more comprehensive remediation. However, they have never made a decision that went with the no-action alternative because it was politically unacceptable. Government bodies have a very difficult time giving yes answers, as they can only lead to trouble. Something on the order of a federally preemptive, attainable risk-based groundwater standard would be a logical place to start. A federal system which includes technology and siting controls is also called for, along with groundwater discharge permits. The author believes that the answer to groundwater protection is to go back and design facilities that don't pollute the groundwater. But for existing discharge sites, there should be a permitting system which sanctions levels of non-harmful groundwater contamination. (See also W90-09063) (Fish-PTT)
W90-09071

HOW CLEAN IS CLEAN GROUND WATER REMEDIATED BY IN SITU BIORESTORATION.
C. H. Ward, and J. M. Thomas.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 225-233, 23 ref.

Descriptors: *Bioremediation, *Biorestoration, *Groundwater quality, *Groundwater resources, *In situ treatment, *Water pollution treatment, *Water quality management, Biodegradation, Environmental protection, Groundwater pollution, Hydraulic permeability, Legislation, Limiting nutrients, Organic pollutants, Site remediation, Water quality standards.

Contamination of groundwater with hazardous chemicals has resulted in various remedial technologies to restore this limited resource. In situ biorestoration involves the use of the indigenous microflora to degrade subsurface contaminants, and is an attractive treatment option because the contaminants are degraded to innocuous material rather than transferred to another environment or temporarily immobilized. Successful treatment using biological reclamation depends on the presence of microorganisms, the intrinsic metabolic capabilities of the microorganisms, the presence of nutrients, the permeability of the aquifer, and the state and/or federal requirements for minimum acceptable levels of pollution. Of primary importance is the permeability of the aquifer to be remediated.

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Oxygen and limiting nutrients can be supplied optimally through aquifers with high hydraulic conductivities. The minimum concentration of an organic compound that can be achieved in the subsurface will probably be site-specific and depend on the types of microorganisms and concentrations of nutrients present. Removal of subsurface contaminants during in situ biorestoration procedures is often biphasic. The initial rates of removal are rapid but often decline as the concentration of contaminants reaches the low ppm range. In the event of a threshold below which biodegradation does not occur, physical and/or chemical treatment schemes may be used to further reduce the levels of contaminants. More research is needed to investigate methods to lower thresholds for chemicals of environmental concern. (See also W90-09063) (Fish-PTT)
W90-09072

RISK CALCULATION AS A STANDARD FOR CLEANUP.
For primary bibliographic entry see Field 6B.
W90-09073

HOW CLEAN IS CLEAN: HOW DO WE DECIDE WHAT TO DO.
T. W. Devine.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 243-249.

Descriptors: *Cleanup, *Groundwater pollution, *Groundwater quality, *Groundwater resources, *Legislation, *Water pollution treatment, *Water quality management, Drinking water, Environmental protection, Public health, Regulations, Risk assessment, Superfund, Water quality standards.

In the public's eye drinking water is groundwater, or groundwater can be drinking water. There is very strong pressure to define how clean is clean, and the pressure comes from the public and through Congress. The general statement is always made that it is necessary to clean up to levels that are safe for public use and that are environmentally protective. The argument is over what is public use, what is safe, and what is environmentally protective. The groundwater protection strategy is going to be a baseline that programs are going to follow, depending on how it evolves. Superfund Amendments and Reauthorization Act, in Section 121, added some very significant additional items into the debate on Superfund site cleanup. One of these is risk reduction through destruction or detoxification of hazardous wastes by employing treatment technologies which reduce toxicity, mobility, or volume, rather than just providing for prevention of exposure. That is a different philosophy from the one that the program was originally operating on under Comprehensive Environmental Response, Cleanup, and Liability Act, when it was originally passed. Remedial actions will attain the applicable or relevant and appropriate requirements, called ARARs, of other federal statutes and state requirements to the extent applicable. In the case of Superfund the fund balancing provision has not gone away. Institutional controls do have a place in cleanup actions, but there are some difficulties with long-term enforcement of those institutional controls; they are not applicable everywhere. The presence of multiple constituents of concern clearly complicates review. A policy is evolving but it is a highly controversial one, and it is receiving and will continue to receive extensive debate. Eventually there will be consistency between Superfund and RCRA in defining how clean is clean and how Superfund sites and solid waste management units are addressed. Clearly, risk analysis is playing now and will continue to play a very important role in how the program evolves. (See also W90-09063) (Fish-PTT)
W90-09074

NEW APPROACH TO THE DISPOSAL OF SOLID WASTE ON LAND.
For primary bibliographic entry see Field 5E.

W90-09075

WASTE SITE REMEDIATION TECHNOLOGY.
R. F. Kissell.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 295-299.

Descriptors: *Cleanup, *Groundwater pollution, *Groundwater quality, *Site remediation, *Waste treatment, *Water pollution treatment, *Water quality management, Cleanup operations, Containment, Decision making, In situ treatment, Incineration, Management planning, Soil contamination.

Remedy selection at a waste site generally involves two steps: determination of the level of contaminants that can exist at sites (commonly known as 'how clean is clean'), and selection of the technology to achieve the desired level. The level and the remedy selections are interconnected, and there is a give and take between regulators and the regulated community whenever cleanup decisions are made. Ample technology exists today to judiciously spend everything available cleaning up waste sites, making enormous progress at remediating contaminated groundwater, and other problems, and still have the opportunity to develop, demonstrate, and apply emerging technologies. The three general kinds of problems associated with waste sites are contaminated residues, contaminated groundwater, and contaminated soil. By thinking in terms of these three categories, the technologies can be identified that will provide enormous progress toward cleanup, and priorities can be identified that maximize the benefit of expenditures. Regarding contaminated soil, a frequently proposed remedy is incineration or other thermal oxidation technology. However, any time dirt is burned, the end product is 'burned dirt'. It is unclear what one could or should do with 500,000 cu yd of burned dirt. Containment, on the other hand, is frequently attacked with questions of long-term liability. In situ bioreclamation is a potential technology that is receiving attention at the present time, however additional research is needed to understand its mechanisms better and to assure its proper use in clean-up. The two principal barriers to cleanup are the need to develop and demonstrate emerging technologies and the difficulty in making decisions. (See also W90-09063) (Fish-PTT)
W90-09077

CURRENT AND EMERGING TECHNOLOGIES IN REMEDIATION.
J. B. Robertson.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 301-311.

Descriptors: *Bioremediation, *Groundwater pollution, *Groundwater quality, *Site remediation, *Water pollution treatment, *Water quality control, Air stripping, Biodegradation, Chemical treatment, Cost analysis, Fate of pollutants, In situ treatment, Landfills, Leaching, Organic pollutants, Soil contamination, Volatile organic compounds.

Remedial action for ground and soil contamination problems is a timely and important issue. Some of the current and commonly practiced technologies in remedial action are: volatilization, biodegradation, leaching and chemical reaction, passive remediation, vitrification, land treatment and a variety of thermal treatments, asphalt incorporation, other solidification techniques, groundwater extraction and treatment, chemical extraction, and simply picking it up and moving it to a landfill or somewhere for excavation and removal. In terms of the common pump and treat system, several methods can be used: air stripping, water separators, biological treatment, chemical treatment, or carbon absorption. More field data is needed on the long-term effectiveness and cost of these remedial ac-

tions. Better decision tools, more technical expertise, and a stronger research and development program are needed. (See also W90-09063) (Fish-PTT)
W90-09078

RECENT ADVANCES IN THE IN SITU MANAGEMENT OF UNCONTROLLED WASTE DISPOSAL SITES.
R. D. Mutch.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 313-332, 5 fig, 13 ref.

Descriptors: *Biodegradation, *Cleanup, *Groundwater pollution, *Groundwater quality, *Hazardous wastes, *Waste management, *Hydrocarbons, *In situ treatment, *Site remediation, *Water pollution treatment, Air stripping, Bioremediation, Biotransformation, Groundwater resources, Oil pollution, Organic pollutants, Superfund.

It is clear that passage of the Superfund Amendments and Reauthorization Act will prompt even greater interest in in situ management remedial technologies, particularly those which can render the waste less toxic, less mobile or less voluminous. Perhaps the most promising is the technology of in situ treatment, both biological treatment of organic waste and chemical treatment of inorganic contaminants. It is also clear that this technology is in its infancy and that great strides will likely be made in the next decade. The technology already has an impressive, documented success record in the treatment of petroleum hydrocarbons and other relatively biodegradable materials. The same can be said of in situ vapor stripping, which has worked quite well where the geohydrological and chemical factors are amenable. It is also evident that many Superfund sites are unamenable to in situ treatment technologies at their current level of development, and are likely to remain so for some time. It is in these cases that the in situ containment technologies will continue to play an important role in waste site remediation. It also seems likely that the mandate for treatment will frequently lead to the conjunctive application of in situ treatment and in situ containment technologies at Superfund sites. (See also W90-09063) (Fish-PTT)
W90-09079

GROUND WATER CLASSIFICATION.
M. Mlay.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 339-351, 1 fig.

Descriptors: *Classification, *Groundwater pollution, *Groundwater quality, *Groundwater resources, *Water pollution control, *Water resources management, Cleanup, Cost-benefit analysis, Environmental protection, Groundwater management, Safe Drinking Water Act, Water supply.

Groundwater protection presents a major challenge to the nation. The costs of detection, prevention, and cleanup are substantially higher than any experienced in other areas of environmental protection. The ability of all levels of government to manage groundwater for its intended uses is vastly difficult and controversial. New understanding and ideas are needed to attain a workable approach. An important development in the effort to protect groundwater in a logical and efficient manner was the issuance of EPA's Ground Water Protection Strategy in 1984, which addresses strengthening EPA's organization for groundwater management. This element establishes a differential protection policy which recognizes that different groundwaters merit different levels of protection, and presents a classification system that identifies three classes of groundwater: Class I--Special groundwaters; Class II--Current or potential sources of drinking water; and Class III--Groundwaters not considered potential sources of drinking water.

The Wellhead Protection Program authorized under the Safe Drinking Water Act Amendments of 1986 requires states to develop plans aimed at protecting the wellhead areas of all public water supply systems within their jurisdiction 'from contaminants that may have adverse affect on persons.' EPA believes that the groundwater classification system and Wellhead Protection Program are significant steps toward rationalizing the approach to the problem of groundwater contamination, and effectively moving toward sound solutions. (See also W90-09063) (Fish-PTT)
W90-09080

GROUND WATER CLASSIFICATION: GOALS AND BASIS.
T. M. Schad.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 353-360, 4 ref.

Descriptors: *Classification, *Groundwater management, *Groundwater pollution, *Groundwater quality, *Water pollution control, *Water quality management, Degradation, Environmental protection, Institutions, Policy making, Public participation, Water pollution sources, Water quality standards.

The classification of groundwater and/or aquifers has been the subject of a great deal of controversy as the nation attempts to evolve a strategy for protecting groundwater. In an effort to evolve a workable policy for groundwater management, the National Ground Water Policy Forum has been created. The Forum membership includes representatives of state and local government agencies, industry, and the environmental community, plus several scientists, lawyers, and administrators with knowledge of groundwater problems. The Forum proposed that states implement a ten-point program of groundwater management which included the classification of aquifers as an essential element. The U.S. EPA promulgated a groundwater protection strategy that included a three-level system of classification for differential protection of groundwater quality. A basic question raised by the EPA classification system is whether it is appropriate to mandate the prescribed three-class system for all parts of the country. Another important question relates to whether the classification system should be expressed in terms of ambient water quality standards, degree of degradation allowed, or stringency controls placed on potential sources of contamination. The basis for classification as recommended by the Forum, is that it becomes a salient part of a multi-faceted attack on the problem of groundwater management. (See also W90-09063) (Fish-PTT)
W90-09081

DEVELOPMENT OF A GROUND WATER MANAGEMENT AND AQUIFER PROTECTION PLAN.
W. A. Pettyjohn.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 387-404, 6 fig.

Descriptors: *Community development, *Groundwater management, *Groundwater pollution, *Groundwater quality, *Water pollution control, Aquifers, Environmental protection, Management planning, Monitoring, Policy making, Regulations, Water quality management.

Small communities which depend on wells as a source of water supply have special cause to develop a groundwater management and aquifer protection plan. The best solution to the potential for contamination of a water supply is the timely development, monitoring, and enforcement of a plan that will protect the groundwater system. An organizational structure must be established to assign responsibility, to maintain the plan, and to organize

a chain of command. This could be done by a local citizen's group or the city council. Although any management plan must be flexible, a number of steps can be followed that should make the plan easier to follow. Although certainly not inclusive, the following steps at least could be taken: (1) determine where the supply originates and what problems might be associated with it, (2) learn the system, (3) locate potential sources of contamination, (4) develop a system of situation monitoring, (5) consider alternate sources of supply, (6) locate and evaluate existing laws and regulations on waste disposal, (7) develop an aquifer sensitivity model, and (8) determine background chemical quality of the supply. There is no doubt that prevention of groundwater contamination is far less costly than attempts to restore an aquifer. However, accidents do happen, and the farsighted municipality will be prepared to initiate solutions if they have a well-developed aquifer management/protection plan available and a chain of command intact. (See also W90-09063) (Fish-PTT)
W90-09084

GROUND WATER: A STATE GOVERNMENT PERSPECTIVE.
R. S. DeHan.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 413-420.

Descriptors: *Florida, *Groundwater pollution, *Groundwater quality, *Water pollution control, *Water quality standards, Classification, Drinking water, Environmental protection, Groundwater management, Management planning, Monitoring, Policy making, Regulations, Standards.

Florida can be viewed as a microcosm of about every possible environmental problem that can be encountered. It can also be viewed as a microcosm of the variety of programs that have been implemented to deal with these problems and threats. These programs include: (1) classification of the groundwater into potable and nonpotable water on the basis of water quality and geological confinement; (2) development of a permitting mechanism; (3) regulation of groundwater discharge; (4) enforcing groundwater standards identical to the primary and secondary drinking water standards listed in the Safe Drinking Water Act; (5) requiring monitoring of facilities discharging to the groundwater; (6) enforcement of violation of the standards; (7) development of source-specific programs and rules; (8) establishment of a statewide groundwater monitoring network; (9) creation of a fund to finance corrective action; (10) creation of a fund to finance cleanup of contamination from leaky gasoline tanks; (11) creation of an 'amnesty days' program; (12) regulation of water quantity and aquifer levels; (13) establishment of an environmental data cooperation program; (14) monitoring representative private wells for drinking water quality parameters; (15) expansion of requirements for monitoring public water supply wells; and (15) banning the disposal of hazardous waste on land or through underground injection. The State of Florida is in the process of developing a Wellhead Protection program designed to prevent pollution of public water supply wells. It is hoped that Florida will have an ongoing program in place by the time EPA begins to develop the federal criteria. (See also W90-09063) (Fish-PTT)
W90-09086

PUBLIC PARTICIPATION IN GROUND WATER PROTECTION.
D. Duxbury.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 421-427.

Descriptors: *Groundwater management, *Groundwater pollution, *Groundwater quality, *Public participation, *Waste disposal, *Water pol-

lution control, Cleanup, Environmental protection, Hazardous wastes, Management planning, Policy making, Regulations, Water quality standards.

Prevention of groundwater contamination must be based upon a commitment to public participation. But first there must be an appreciation that there is a problem, and there must be a commitment to work on it from all of its different aspects. The League of Women Voters is an organization that is already a part of that strong coalition to prevent contamination and protect groundwater. There has been a great concern within the League for the whole hazardous waste management area. The second area of concern is to be far more careful than in the past in the use of underground injection for the disposal of hazardous wastes. There is also concern about small quantity generators. The area of household hazardous wastes collection programs is one in which the League has been very active. These collection programs have proved to be a unique vehicle for cooperative efforts between government, industry, and public interest groups. The League has been very concerned about reducing the generation of waste, and believes that it is essential that there be greater public understanding and awareness of the efforts to reduce waste in industries, and also significantly higher levels of communication between generators and the public. There are many other areas that the League has also been concerned about: land use planning, nonpoint source contamination, and 'how clean is clean.' Public emphasis must be placed on those areas where there is support of cooperative efforts and also help to have a significant positive impact on the problem of groundwater contamination. (See also W90-09063) (Fish-PTT)
W90-09087

NON-POINT SOURCE POLLUTION FROM IRRIGATED WATERSHEDS: AN ASSESSMENT AND MANAGEMENT WITH REGARD TO CLIMATIC CHANGES.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2A.
W90-09096

CHANGES OF WATER RESOURCES (ABOUT WATER MANAGEMENT OF HUNGARY).
Ministry of Environment and Water Management, Budapest (Hungary).
For primary bibliographic entry see Field 2A.
W90-09103

QUANTITATIVE ANALYSIS FOR THE CLEANUP OF HYDROCARBON-CONTAMINATED SOILS BY IN-SITU SOIL VENTING.
Shell Development Co., Houston, TX.
P. C. Johnson, M. W. Kemblowski, and J. D. Colthart.
Ground Water GRWAAP, Vol. 28, No. 3, p 413-429, May/June 1990. 16 fig, 3 tab, 14 ref.

Descriptors: *Cleanup operations, *Gasoline, *Hydrocarbons, *Mathematical models, *Model studies, *Path of pollutants, *Soil contamination, *Ventilation, Aeration, Permeability, Quantitative analysis, Soil porosity, Temperature effects, Vaporization, Volatility.

The efficiency of any soil venting operation will depend significantly on three factors: vapor flow rate, vapor flow path relative to the contaminant distribution, and composition of the contaminant. Simple mathematical models were developed to be used as screening tools to help determine if soil venting will be a viable remediation option at any given spill site. The models relate the applied vacuum, soil permeability, and spill composition to the vapor flow rates, velocities, mass removal rates, and residual composition changes with time. Model predictions are presented for a hypothetical gasoline spill to illustrate the type of behavior that is expected in a typical soil venting operation. The results illustrate the advantages and limitations of venting as a remediation tool, under both ideal and nonideal conditions. The rate of gasoline removal rapidly decreases over a period of a few days, then

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Group 5G—Water Quality Control

continues to decrease less rapidly over the next few months. After a period of 400 days, about 90% of the initial hydrocarbon has been removed. Model predictions indicate that the soil moisture content, or other soil properties do not significantly influence the venting removal rates. Colder temperatures might be expected to slow venting operations. The vapor-phase diffusion-limited model is presented for situations in which hydrocarbon is trapped within a low-permeability layer, or is present as a layer of free-product. Results indicate that, even under the best conditions, the efficiency of venting from heterogeneous systems will be lower than from homogeneous systems. If conditions favor vapor flow through a contaminated region at reasonable flow rates, then soil venting will efficiently remove the more volatile compounds from hydrocarbon mixtures, such as benzene, toluene, and the xylenes. (Geiger-PTT)
W90-09142

TWO APPROACHES TO DESIGN OF MONITORING NETWORKS.
Geological Survey, Boise, ID.
For primary bibliographic entry see Field 7A.
W90-09143

PRESERVING MINNESOTA'S NATURAL HERITAGE.
N. T. French.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 2, p 16-22, Winter 1990. 4 fig, 11 ref.

Descriptors: *Minnesota, *Water conservation, *Wildlife conservation, Ecological effects, Environmental effects, Natural resources, Prairies, Wetlands, Wildlife habitats.

Minnesota has a rich natural resource base that can be preserved only by maintaining and expanding private and public conservation programs that contribute toward the protection of forests, soils, waters, native plants, wildlife, natural communities, and endangered species. Increasing pressure to plow up prairie, drain wetlands, consume old growth forest resources, and urbanize the landscape continue to erode an ever-decreasing base of natural habitat. More than 72% of Minnesota's original wetlands, and nearly all of the prairie wetlands, have disappeared from the landscape in the last 130 years due to public and private drainage programs. By the early 1900s, both the federal and state government were taking action to set aside vast areas of land, mostly in northern Minnesota for forestry purposes. Throughout the next few decades, natural areas and parks were set aside to preserve the natural heritage of the state. In June of 1954, the Bureau of Game initiated a crusade to save Minnesota's wetlands. Funding for land conservation was enacted through the Omnibus Natural Resources and Recreation Act of 1963 and the Outdoor Recreation Act and Resource 2000 program of 1975. The 1984 Reinvest in Minnesota Program also supports programs to protect and preserve forest, prairie, and aquatic habitat. The Minnesota Natural Heritage Inventory Program was established in 1979 to conduct field inventory and research on the numbers, condition, and distribution of rare plants and animals, ecologically sensitive plant communities, and other natural features now uncommon on the landscape and maintain an extensive database documenting their occurrence. Minnesota's state scientific and Natural Areas Program was established to protect and manage natural ecological communities and unique natural resources. In 1988 the Minnesota Environment and Natural Resources Trust Fund was established to fund long-term protection, conservation and preservation and enhance air, water, land, fish, wildlife and other natural resources. (Geiger-PTT)
W90-09144

ALLOCATIVE EFFICIENCY IMPLICATIONS OF WATER POLLUTION ABATEMENT COST COMPARISONS.
Pennsylvania State Univ., University Park. Dept. of Agricultural Economics and Rural Sociology.
J. S. Shortle.
Water Resources Research WRERAQ, Vol. 26,

No. 5, p 793-797, May 1990. 13 ref.

Descriptors: *Cost allocation, *Economic aspects, *Model studies, *Water pollution control, Average flow, Cost analysis, Economic efficiency, Marginal costs, Probabilistic process, Standards, Stochastic emissions, Water quality standards.

An economic model of stochastic emissions was used to demonstrate that misleading results could be obtained from efficiency analyses using the commonly used approach which usually sidesteps the stochastic element by measuring pollution control and control costs with respect to changes in long-term average flows. An alternative theoretical approach for evaluating the cost-effectiveness of pollution control allocations is suggested. It involves comparison of least cost adjustments in the mean, variance, and other moments of emissions, with the objective being to allocate moments so as to minimize the costs of achieving stochastically equivalent or preferred distributions of ambient concentrations. For such an analysis, pollution control costs for individual sources would need to be defined over several moments, depending on the choice of criterion for preferred distributions and the form of the aggregate distribution. The first choice for a criterion for identifying preferred distributions would be expected damage costs, but limited information on damage cost functions would require the use of alternatives. The use of average abatement cost comparisons is a special case of this approach in which zero weight is given to the effects of control on moments other than the mean. Although obviously difficult to implement, water pollution control planning could be improved by giving explicit weights to additional moments in cases involving increasing marginal damage costs. (Cassar-PTT)
W90-09153

OPTIMIZATION OF THE PUMPING SCHEDULE IN AQUIFER REMEDIATION UNDER UNCERTAINTY.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
R. Andricevic, and P. K. Kitanidis.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 875-885, May 1990. 5 fig, 1 tab, 30 ref, append. National Science Foundation Grants CEE-8420664 and ECE-8517598.

Descriptors: *Cost analysis, *Groundwater pollution, *Model studies, *Pumping, *Site remediation, *Wastewater treatment, *Water pollution treatment, Aquifers, Costs, Economic aspects, Groundwater quality, Mathematical models, Monitoring wells, Optimization, Waste management, Wells.

An optimization methodology was developed to reduce the parameter uncertainty in aquifer remediation schemes of the 'pump and treat' type. It was shown that in an average sense, the cost consists of two parts: one which depends only on the best estimates and another which increases with the error in parameter estimation. Using asymptotic approximations, the second term was calculated analytically as a function of the mean square estimation error. The optimum solution was obtained by minimizing the sum of the two terms. The new procedure involves estimation (or inverse modeling) as well as optimization. It is generally preferable not to decouple estimation from optimization. The control policy (pumping schedule) optimizes the objective function by improving the accuracy of estimation of system parameters (i.e., dispersivity, transmissivity). The method was applied to a simple situation, consisting of a one-dimensional, confined aquifer system with unsteady flow, one disposal site, one pumping well, and one observation well. The background solute concentration was 10 mg/liter, and the constant solute concentration at the injection well was 100 mg/liter. The new procedure is superior to an optimization method which neglects uncertainty in parameter estimation. (Cassar-PTT)
W90-09162

DIFFUSION COEFFICIENTS IN GRAVEL UNDER UNSATURATED CONDITIONS.

Battelle Pacific Northwest Labs., Richland, WA.
J. L. Conca, and J. Wright.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 1055-1066, May 1990. 14 fig, 4 tab, 31 ref. U.S. Department of Energy Contract DE-AC06-76RLO 1830.

Descriptors: *Aeration zone, *Diffusion coefficient, *Gravel, *Hazardous waste disposal, *Path of pollutants, *Soil water, *Water pollution prevention, Backfill, Particle size, Radioactive wastes, Waste disposal.

Diffusion coefficients were experimentally determined in unsaturated gravel to evaluate the effectiveness of gravel as a diffusion barrier to ionic transport in the vadose zone. Water contents were fixed by use of an ultracentrifuge with an ultralow constant rate flow pump supplying solution to the sample via a rotating seal. Once the gravel was at hydraulic steady state, the electrical conductivity was measured, and the diffusion coefficient calculated using the Nernst-Einstein equation. Diffusion coefficient values for potassium ion were determined in four types of angular gravel as follows: 6.3 to 9.5 mm granitic gravel at a volumetric water content of 5.5%, 1.7 x 10 to the minus 7th power sq cm/s; 1.4 to 2.8 mm quartzite gravel with a water content of 0.56 to 5.1%, 5.7-75 x 10 to the minus 9th power sq cm/s; 4.0 to 6.3 mm quartzite gravel with a water content of 0.47 to 2.8%, 0.22-1.11 times 10 to the minus 9th power sq cm/s; and 4.0 to 6.3 mm basalt gravel with a water content of 0.81 to 5.3%, 4.3-150 times 10 to the minus 9th power sq cm/s. Variations in the potassium diffusion coefficient values resulted primarily from differences in water content, which depends on gravel type and particle size. (Cassar-PTT)
W90-09176

DEVELOPING A PLAN TO MANAGE LAKE VEGETATION.
Wisconsin Geological and Natural History Survey, Madison.
S. A. Nichols, S. Engel, and T. McNabb.
Aquatics, Vol. 10, No. 3, p 10-19, 1988. 4 fig, 12 ref.

Descriptors: *Aquatic weed control, *Environmental policy, *Lake management, *Lake restoration, *Planning, *Plant management, Carp, Herbicides, Nutrients, Plant ecology, Regulations.

A successful plan to manage lake vegetation is built on four principles: (1) Defining the problem; (2) Understanding plant ecology; (3) Considering all techniques; and (4) Monitoring the results. Choice of plant control strategies should be guided by three principles: (1) Consider all methods; (2) Separate management strategies by lake use; and (3) Weigh each method's benefits against its cost and environmental impacts. Each chemical, mechanical, habitat manipulation, and biological technique has limitations, short and long-term consequences, and environmental risks. Hidden costs for maintaining equipment, repeating treatment, and restoring habitat need to be considered. Any method must comply with local, county, state, and federal restrictions before using any method. Many states, for example, ban stocking of grass carp and require a permit to apply chemical herbicides. Few states require a permit for mechanical harvesting, but local ordinances may govern where the harvest can be dumped. Nearly every technique has some restrictions. A lake management plan is an orderly approach to plant management. It helps define the problem, set priorities, develop management strategies, and evaluate progress. As an educational tool, it can describe the what, how, why, and where of management techniques. As a team effort, a plan can focus community involvement. The plan should integrate management techniques. Partial winter drawdown and screening for inshore control can be combined with offshore harvesting. Herbicides or harvesting can reduce the number of sterile grass carp needed for stocking. Spot dredging can coincide with winter drawdown. Most important, a lake management plan can be integrated with watershed management to control both internal and external nutrient loading. (Chonka-PTT)

W90-09202

IMPACT OF INTERNAL PHOSPHORUS LOADING ON THE RESTORATION OF TROUT LAKE.
North Dakota Univ., Grand Forks. Dept. of Chemical Engineering.
J. S. Goetzman.
Environmental Progress ENVPDI, Vol. 9, No. 2, p 69-72, May 1990. 2 fig, 3 tab, 6 ref.

Descriptors: *Eutrophic lakes, *Eutrophication, *Lake restoration, *Minnesota, *Phosphorus, *Trout Lake, Analytical techniques, Baseline studies, Data acquisition, Dissolved oxygen, Limnology, Model studies, Trophic level, Wastewater pollution, Water analysis.

The accelerated eutrophication of many lakes is a problem of increasing concern. The increase in photosynthetic productivity may decrease water clarity, alter dissolved oxygen profiles, and decrease the aesthetic value of a lake. For those lakes which possess high levels of water quality, the need for lake management arises. Trout Lake, located in Itasca County near Coleraine, Minnesota, provides a case in point as it has experienced a reduction in water quality over the last 40 years. Several conclusions may be drawn as a result of a 1987 study on Trout Lake. First, based upon total phosphorus concentrations, the lake could be considered eutrophic with a trophic state index value of 60. Second, the Trout Lake model can be used to predict and assess future impacts on the lake's trophic state due to restoration procedures assessing the impact of sewage diversion, as the Trout Lake model predicts a spring turnover concentration of 0.061 mg/L for the lake after sewage diversion. Third, an experimental procedure was developed to determine internal phosphorus release rates using a novel approach to creating anoxia in the laboratory. Results of these tests were correlated to lake release rates to provide a method to monitor lake release rates without heavy field sampling. (Chonka-PTT)
W90-09209

EPA'S ASSESSMENT OF EUROPEAN CONTAMINATED SOIL TREATMENT TECHNIQUES.
Environmental Protection Agency, Washington, DC. Office of Modeling, Monitoring Systems and Quality Assurance.
T. H. Pheiffer, T. J. Nunno, and J. S. Walters.
Environmental Progress ENVPDI, Vol. 9, No. 2, p 79-86, May 1990. 2 fig, 5 tab, 8 ref.

Descriptors: *Biological treatment, *Decontamination, *Europe, *Site remediation, *Soil treatment, *Water pollution prevention, *Water pollution treatment, Hazardous waste disposal, Soil contamination, Vadose zone.

Site remediation is a pressing issue in European countries due to limited availability of land. Therefore, much progress is being made in the development of effective technologies for remediating contaminated sites. The most successful and innovative European technologies were investigated for potential introduction into U.S. markets. Ninety-five innovative technologies either in use or being researched in foreign countries were identified. The most promising technologies identified were studied in depth through personal interviews with the engineers who research and apply these technologies, and through tours of laboratory models and full-scale installations. The most successful full-scale technologies investigated were developed in the Netherlands and West Germany. These technologies include vacuum extraction of hydrocarbons from soil, in situ washing of cadmium-polluted soil, in situ steam stripping, and a number of landfarming and soil washing operations. The cadmium extraction project employed in situ hydrochloric acid leaching of cadmium from over 30,000 cu mi of soil. The acid leachate was purified by ion exchange and reused. The treatment cost was estimated to be $75/ton of soil. Hannover Umwelttechnik (HUT) of West Germany has installed over 300 vacuum extraction systems for vadose zone decontamination. HUT has also developed an in situ air stripping system for removing volatiles from ground water in conjunction with vacuum extraction. Treatment costs for the HUT system are less than $5/ton. Soil washing can be conducted on a large scale at costs substantially lower than those of incineration (with notably less effectiveness). Biological treatment technologies were shown to be useful both for polishing to lower concentrations using in situ treatment, and for gross removals of organic materials using rotating biological contactors and composting systems. (Chonka-PTT)
W90-09210

TOXIC SUBSTANCES IN SURFACE WATER.
George Washington Univ., Washington, DC. Div. of Occupational and Environmental Medicine.
J. A. Foran.
Environmental Science and Technology ESTHAG, Vol. 24, No. 5, p 604-608, May 1990. 2 tab, 13 ref.

Descriptors: *Carcinogens, *Clean Water Act, *Great Lakes, *Public health, *Risk assessment, *Surface water, *Toxicology, *Water pollution control, *Water quality standards, Detection limits, Jurisdiction, Lake Michigan.

The use of a procedural approach to develop numeric criteria in state water quality standards (WQS) programs to protect human health from the impacts of carcinogens and noncarcinogens provides flexibility in regulating toxic substances in surface water and protecting human health. Two examples of criteria derivation (for carbon tetrachloride and endrin) demonstrate how the choice of an acceptable cancer risk level and various exposure assumptions can influence criteria that are developed to protect human health from the impacts of toxic substances in surface waters. The use of the procedural approach, however, has some important disadvantages. First, where several states, such as those surrounding Lake Michigan, share one surface water system, use of state-specific procedures to develop human health criteria may result in different criteria for the same toxic pollutant and will result in different levels of regulation of the pollutant between states for the same water body. A state that has chosen less conservative exposure assumptions and derived a less stringent criterion for a toxic pollutant may require a less stringent degree of regulation for discharges of that pollutant. Different levels of protection of the shared resource then will occur, as will competition for industry and its associated economic advantages. Second, water quality criteria for carcinogenic substances, often are several orders of magnitude below the analytical capabilities available to detect those substances in surface waters. For example, Wisconsin's carcinogenic criterion for polychlorinated biphenyls in Lake Michigan is 0.15 ng/L, generally 3-4 orders of magnitude below the concentration detectable by standard commercial methods available to state agencies. States in the Great Lakes basin have dealt with this problem generally by recognizing the analytical level of detection (LOD) as the point for regulatory action. However, this may result in substantial contamination of biota and potential health impacts on human consumers of these biota, because the discharge of pollutants at concentrations below the LOD may nevertheless exceed a water quality criterion. (Chonka-PTT)
W90-09214

EFFICIENT DEGRADATION OF TRICHLOROETHYLENE BY A RECOMBINANT ESCHERICHIA COLI.
Amgen, Thousand Oaks, CA.
R. B. Winter, K. M. Yen, and B. D. Ensley.
Bio/Technology BTCHDA, Vol. 7, No. 3, p 282-285, March 1989. 3 fig, 2 tab, 19 ref.

Descriptors: *Bacteria, *Biodegradation, *Biological treatment, *Escherichia coli, *Microbial degradation, *Trichloroethylene, *Water pollution treatment, Genetic engineering, Pseudomonas, Recombinant DNA, Toluene, Water pollution.

Trichloroethylene is among the most significant of environmental pollutants. Biodegradation is potentially the most cost effective means for reducing trichloroethylene contamination. Trichloroethylene has been shown to persist in the environment, however, suggesting that its degradation by indigenous microorganisms is extremely slow. A strain of Pseudomonas mendocina that oxidizes trichloroethylene after growth in the presence of toluene was identified. A DNA fragment from this organism, when introduced into the appropriate expression vector system, conferred upon Eschericha coli the ability to oxidize both toluene and trichloroethylene. The recombinant E. coli rapidly degraded trichloroethylene to carbon dioxide, chloride ion and simple water soluble metabolites and reduced the concentration of trichloroethylene in water as much as 1000-fold. The extensive degradation of trichloroethylene by the recombinant E. coli was due to genetic manipulations that uncoupled the regulation of trichloroethylene degrading enzymes from growth and co-metabolism of toluene. (Mertz-PTT)
W90-09231

LAKE DYNAMICS AND THE EFFECTS OF FLOODING ON TOTAL PHOSPHORUS.
National Hydrology Research Inst., Saskatoon (Saskatchewan).
For primary bibliographic entry see Field 2H.
W90-09233

COMPARISON OF DISCHARGE METHODS AND HABITAT OPTIMIZATION FOR RECOMMENDING INSTREAM FLOWS TO PROTECT FISH HABITAT.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
For primary bibliographic entry see Field 8I.
W90-09250

INHIBITION OF THE GROWTH OF ENTEROPATHOGENIC BACILLI BY BACTERIOCINS PRODUCED BY MICRO-ORGANISMS FROM THE SEDIMENT OF WELLS.
Talca Univ. (Chile). Dept. of Biological Sciences.
C. Padilla, P. Brevis, A. Said, and R. Molina.
Journal of Applied Bacteriology JABAA4, Vol. 68, No. 3, p 289-295, March 1990. 3 fig, 3 tab, 12 ref.

Descriptors: *Bacteria, *Bacterial analysis, *Fate of pollutants, *Pathogenic bacteria, *Sediments, *Well water, Chile, Drinking water, Escherichia coli, Inhibition, Microbiological studies, Rural areas, Salmonella, Sediment analysis, Shigella, Water supply.

The bacterial flora of the sediment of 20 wells of water for human consumption in the rural area of the VII region in Chile was examined. Fourteen strains of bacteria, from different wells, produced bacteriocins which inhibited the growth of Salmonella typhi, Salmonella typhimurium, Shigella sonnei, and enterotoxigenic Escherichia coli. About 50% of these strains contained plasmids of different molecular weights and a large number of these coded for bacteriocins. Thus, bacteriogenic strains adapted to the natural conditions of well sediment, may provide a means of controlling the number of enteropathogenic bacilli in rural well water. (Author's abstract)
W90-09273

SITE ASSESSMENTS FOR REAL ESTATE TRANSACTIONS.
Parsons, Brinckerhoff, Quade and Douglas, Inc., Denver, CO.
T. K. Martella.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 2, p 79-82, Spring 1990. 3 ref.

Descriptors: *Environmental policy, *Environmental protection, *Hazardous wastes, *Legal aspects, *On-site investigations, Administrative regulations, Cleanup operations, Economic aspects, Pollutant identification, Property ownership, Real-estate transactions.

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5G—Water Quality Control

The sometimes serious environmental implications of property ownership cannot be ignored and environmental laws have been enacted to strengthen regulatory agencies' response to these environmental issues. In addition, the EPA has recently stated that it will be more aggressive in issuing administrative orders for remedial designs and actions to get 'potentially responsible parties' (PRPs) for Superfund site cleanups to negotiate site remediations. The EPA stated further that if it does the remedial work, it will seek damages from the PRPs that are triple the cost of cleanup in an effort to force PRPs to do the work or to recover EPA costs. Because of the liabilities involved with real estate ownership, it is imperative that a thorough site assessment be conducted by qualified individuals. The site assessment is a valuable tool in assessing not only the physical condition of the property, but will help identify potential regulatory and other liabilities associated with real estate transactions which include both the purchaser and lender. When conducted, they satisfy due diligence in assessing the previous owners and uses of the property consistent with good commercial or customary practice for potential CERCLA 'innocent land owner immunity' and will identify potential regulatory permitting actions required for environmental protection. (Author's abstract)
W90-09309

FACTORS AFFECTING EFFICIENT AQUIFER RESTORATION AT IN SITU URANIUM MINE SITES.
Boise State Univ., ID. Dept. of Geology and Geophysics.
J. L. Osiensky, and R. E. Williams.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 2, p 107-112, Spring 1990. 7 fig, 10 ref.

Descriptors: *Aquifers, *Cleanup operations, *Groundwater pollution, *Restoration, *Uranium mining, *Water pollution treatment, Aquifer management, Geochemistry, Geohydrology, Groundwater sweeping, Hydrologic properties, Leaching, Natural restoration.

In situ mining of uranium typically requires the injection of a reactive leaching solution (lixiviant) such as sodium carbonate/bicarbonate, ammonium carbonate/bicarbonate, or sulfuric acid, and an oxidant such as hydrogen peroxide or oxygen into an ore-bearing, confined aquifer. It also requires the environmental restoration of the source aquifer. The stratigraphy of sandstone uranium deposits typically consists of interbedded layers of poorly consolidated sands and clays and gravels deposited in fluvial or coastal environments. The parameters that influence the migration of lixiviant during mining and restoration in these environments include induced hydraulic gradients, hydrodynamic dispersion, heterogeneity, anisotropy, physicochemical reactions, leakage into and/or through confining layers, and convergence of flow lines due to partial well penetration. The effectiveness of the various methods of aquifer restoration is site-specific and is dependent upon the site hydrogeology and hydrogeochemistry, and the chemistry of the lixiviant. Possible methods include: groundwater sweeping; forward recirculation; reverse recirculation; directional groundwater sweeping; and natural restoration. Based on the analysis of eight in situ uranium mine sites, directional groundwater sweeping appears to be the most effective hydraulic method of aquifer restoration. The data base on natural restoration is incomplete; however, it appears that several years, and possibly decades, would be needed to approach baseline conditions by natural restoration alone. (White-Reimer-PTT)
W90-09314

PRACTICAL APPROACH TO THE DESIGN, OPERATION, AND MONITORING OF IN SITU SOIL-VENTING SYSTEMS.
Shell Development Co., Houston, TX.
P. C. Johnson, C. C. Stanley, M. W. Kemblowski, D. L. Byers, and J. D. Colthart.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 2, p 159-178, Spring 1990. 19 fig, 2 tab, 8 ref.

Descriptors: *Cleanup operations, *Soil contamination, *Soil venting, *Volatile organic compounds, *Water pollution treatment, Case studies, Field tests, Monitoring, Oil pollution, Site remediation, Vapor extraction.

When operated properly, in situ soil venting or vapor extraction can be one of the most cost-effective remediation processes for soils contaminated with gasoline, solvents, or other relatively volatile compounds. The components of soil-venting systems are typically off-the-shelf items, and the installation of wells and trenches can be done by reputable environmental firms. However, choosing whether or not venting should be applied at a given site is a difficult decision involving: (1) determining what vapor concentrations are likely to be obtained; (2) acceptable removal rates; (3) realistic vapor flow rates; (4) residuals left in soil; and (5) negative effects of venting. If venting is a viable remediation measure, the aquifer characteristics, soil permeability to vapor flow, and vapor concentrations need to be determined. These factors are determined by two field tests: air permeability and groundwater pumping tests. Once the system is designed, the performance of the soil-venting system must be monitored in order to ensure efficient operation and to help determine when to shut off the system. Target soil cleanup levels are often set on a site-by-site basis, and are based on the estimated potential impact that any residual may have on air quality, groundwater quality, or other health standards. Generally, confirmation soil borings, and sometimes soil vapor surveys are required before closure is granted. A service station spill case study is presented that supports the validity and usefulness of a venting system. (White-Reimer-PTT)
W90-09317

INFLUENCE OF BEST MANAGEMENT PRACTICES ON WATER QUALITY IN THE APPOQUINIMINK WATERSHED.
Delaware Agriculture Experiment Station, Newark.
W. F. Ritter, A. E. M. Chirnside, and R. W. Lake.
Journal of Environmental Science and Health (A) JESEDU, Vol. 24, No. 8, p 897-924, 1989. 1 fig, 9 tab, 5 ref.

Descriptors: *Agricultural runoff, *Atrazine, *Delaware, *Nonpoint pollution sources, *Water pollution control, *Watershed management, Appoquinimink watershed, Biological oxygen demand, Groundwater, Monitoring, Nitrates, Nutrients, Surface water, Trazine herbicides.

Surface and groundwater quality were monitored in the Appoquinimink Watershed, Delaware as part of the Appoquinimink Rural Clean Water Project (RCWP). Surface water was monitored for seven years and groundwater was monitored for three years. As part of the RCWP plan, conservation tillage, fertilizer management and pesticide management were the most widely used best management practices. Best management practices decreased total phosphorus and total suspended solids concentrations in surface water. The unfiltered orthophosphorus as a percentage of total phosphorus increased. Nitrogen concentrations did not change over the seven year monitoring period. The BOD concentrations increased because of increased residues left on the surface from conservation tillage. Atrazine was detected in the shallow groundwater at concentrations ranging from 1 to 45 microg/L. Aldicarb was only detected in one monitoring well. Nitrate concentrations were above 10 mg/L in some areas of the watershed. (Author's abstract)
W90-09320

ALGAL ASSAYS TO INTERPRET TOXICITY GUIDELINES FOR NATURAL WATERS.
Ontario Ministry of the Environment, Rexdale. Water Resources Branch.
For primary bibliographic entry see Field 5A.
W90-09324

ENHANCED ANAEROBIC BIODEGRADATION OF VINYL CHLORIDE IN GROUND WATER.
Florida International Univ., Miami. Drinking Water Research Center.
G. A. Barrio-Lage, F. Z. Parsons, R. M. Narbaitz, P. A. Lorenzo, and H. E. Archer.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 4, p 403-415, April 1990. 7 fig, 4 tab, 18 ref.

Descriptors: *Biodegradation, *Fate of pollutants, *Groundwater pollution, *Laboratory methods, *Vinyl chloride, *Water pollution treatment, Anaerobic conditions, Nutrients, Soil contamination.

The enhanced biotransformation of vinyl chloride (VC) under anaerobic conditions was studied using static microcosms and a flow-through column packed with soil from a study site. Vinyl chloride was resistant to transformation in the static microcosms in 5 mo of incubation; however, 89% of the vinyl chloride that was dissolved in the water was transformed when the microbiota in the columns was stimulated with a mixture of nutrients. In the presence of nutrients such as methane, methanol, ammonium phosphate and phenol, the main products of biotransformation were nonchlorinated organics such as methane and ethylene. Sodium acetate, added to the water and soil, did not enhance the biotransformation of VC because acetate-utilizing bacteria were not found at the study site and none developed in soil sample after the 21 d allowed for adaptation. Four biodegradation mechanisms of vinyl chloride under anaerobic conditions were recognized: (a) reductive dechlorination to ethylene; (b) mineralization to methane; (c) formation of chloromethane, probably followed by methane formation; and (d) bio-oxidation to CO2, where acetate and citrate were added. A pseudo-first-order rate constant of 0.00101/mo and a t 1/2 of 57.2 yr were calculated for the disappearance of vinyl chloride in soil and water microcosms under anaerobic conditions, without bioenhancement. (Author's abstract)
W90-09332

RATIONALE FOR OHIO'S DETERGENT PHOSPHORUS BAN.
International Joint Commission-United States and Canada, Windsor (Ontario). Great Lakes Regional Office.
J. H. Hartig, C. Trautrim, D. M. Dolan, and D. E. Rathke.
Water Resources Bulletin WARBAQ, Vol. 26, No. 2, p 201-207, April 1990. 4 tab, 22 ref.

Descriptors: *Detergents, *Lake Erie, *Legislation, *Ohio, *Phosphorus, *Water pollution prevention, Combined sewer overflows, Economic aspects, Great Lakes, Municipal wastewater, Riparian land, Rural areas, Septic tanks, Wastewater pollution, Wastewater treatment facilities.

Ohio signed into law a detergent phosphorus ban on March 26, 1988. This law limits the elemental phosphorus content of household laundry detergents to 0.5% in all 35 Lake Erie counties in Ohio by 1990. Ohio's detergent phosphorus ban will help non-compliant municipal wastewater treatment plants achieve compliance with the 1 mg/L effluent phosphorus standard. By limiting the phosphorus content of household laundry detergents, Ohio will also benefit from less phosphorus entering surface waters from combined sewer overflows, communities with treatment plant bypasses, and riparian homes with septic tanks. This is important because most of the phosphorus in laundry detergents is in the bioavailable form and Ohio's Lake Erie shoreline is particularly sensitive to Cladophora problems. When viewed in conjunction with reduced chemical costs for phosphorus removal and savings in sludge disposal costs, Ohio's detergent phosphorus ban is a pragmatic component of an international phosphorus management strategy to protect the Great Lakes. (Author's abstract)
W90-09343

EFFECTS OF ARTIFICIAL CIRCULATION ON HYPEREUTROPHIC LAKE.
Metropolitan Council, St. Paul, MN.
R. A. Osgood, and J. E. Stiegler.

Water Resources Bulletin WARBAQ, Vol. 26, No. 2, p 209-217, April 1990. 7 fig, 1 tab, 18 ref.

Descriptors: *Aeration, *Artificial circulation, *Eutrophic lakes, *Lake management, *Lake restoration, *Limnology, *Urbanization, Biological oxygen demand, Chlorophyll, Crystal Lake, Cyanophyta, Dissolved oxygen, Dredging, Fishkill, Minnesota, Nitrogen, Oxygen depletion, Phosphorus, Silting, Storm sewers, Transparency, Water quality management.

Crystal Lake, a small urban lake in Robbinsdale, MN, became completely urbanized by 1950. The lake had also been subjected to improper dredging and siltation from storm sewers. The lake was artificially circulated for 12 years (1973-1985) before a detailed water quality evaluation was undertaken. In 1986, the circulation system was shut off for a two-year assessment. Although the lake remained hypereutrophic, the use of the lake, which included shoreline fishing and feeding ducks and geese, did not appear to be seriously impaired by the absence of artificial circulation. The circulation system was returned to service in October 1987 (there are 16 diffusers in this 0.31 sq km lake). Continuous limnological data from October 1987 through October 1988, plus several sampling dates in 1989, compares to the two non-circulation years (1986 and 1987) as follows: there was a two-fold to three-fold increase in the lake's concentration of total phosphorus, total Kjeldahl nitrogen, and chlorophyll and a similar decrease in Secchi disk transparency. The surface oxygen concentration was reduced and the deep waters were nearly anoxic. In fact, following a wind storm in 1988, the entire lake became anoxic due to the mixing of high BOD throughout the water column, and a summertime fish-kill resulted. All of these occurrences are related to the artificial circulation of the lake. (Author's abstract)
W90-09344

ECONOMIC POLICIES FOR REGULATING AGRICULTURAL DRAINAGE WATER.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
K. C. Knapp, A. Dinar, and P. Nash.
Water Resources Bulletin WARBAQ, Vol. 26, No. 2, p 289-298, April 1990. 6 tab, 18 ref.

Descriptors: *Agricultural runoff, *Economic aspects, *Nonpoint pollution sources, *Regulations, *San Joaquin Valley, *Water pollution control, *Water pollution prevention, *Water quality criteria, California, Cotton, Crop production, Irrigation, Literature review.

Agricultural drainage water is a major source of environmental pollution in many areas. The literature on the economics of nonpoint-source pollution was reviewed and applied to the regulation of agricultural drainage water. Four types of regulatory policies were considered: nonpoint standards, nonpoint incentives, management practice standards, and management practice incentives. An empirical analysis was carried out for cotton production in the San Joaquin Valley of California. Variable inputs are the quantity of water applied and the type of irrigation system. All four policies can achieve economic efficiency under the assumed conditions but the policies differ in terms of the distributional impacts and administrative requirements. In all cases the regulatory agency is required to monitor input use on farms and predict drainage volumes in lieu of actually observing the drainage flow. (Peters-PTT)
W90-09353

USE OF AN ECOSYSTEM APPROACH TO RESTORE DEGRADED AREAS OF THE GREAT LAKES.
Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Fisheries Research Branch.
J. H. Hartig, and J. R. Vallentyne.
AMBIO AMBOCX, Vol. 18, No. 8, p 423-428, 1989. 4 fig, 1 tab, 16 ref.

Descriptors: *Ecosystems, *Great Lakes, *International commissions, *Lake restoration, *Water pollution treatment, Canada, Institutional constraints,

International Joint Commission, Public participation, Water pollution prevention.

Two mutually supporting initiatives have arisen under the auspices of the Canada/United States International Joint Commission in the context of the evolution of Great Lakes Water Quality Agreements: an ecosystem approach to resolving problems; and the development of comprehensive remedial action plans to restore 42 degraded areas (i.e., Great Lakes Areas of Concern). The ecosystem approach is a deceptively simple idea of taking account of the interrelationships among water, land, air, and all living things, including people; and involving all user groups in management. The remedial action plan program represents the first opportunity, on a broad and practical scale, to implement an ecosystem approach in the Great Lakes basin. It is an experiment in setting up the institutional arrangements necessary to implement locally designed ecosystem approaches to cleaning up Great Lakes Areas of Concern. The key to implementing an ecosystem approach is establishing a basin committee, stakeholders' group, citizens' advisory committee, or comparable group broadly representative of social, economic, and environmental interests in the affected area. Such groups provide an opportunity to change the traditional way of doing business by increasing the level of interaction. As is the case in all International Joint Commission activities, group members serve in their personal and professional capacities and not as representatives of agencies that employ them. (Author's abstract)
W90-09360

RECENT DEVELOPMENTS IN ENVIRONMENTAL PROTECTION IN INDIA: POLLUTION CONTROL.
H. Govind.
AMBIO AMBOCX, Vol. 18, No. 8, p 429-433, 1989. 1 fig, 1 tab, 42 ref.

Descriptors: *Air pollution control, *Environmental protection, *India, *Water pollution control, Developing countries, Education, Ganges River, Human population, Law enforcement, Public participation, Wastewater treatment.

In India, pollution and environmental degradation have reached alarming dimensions due to poverty, deforestation, industrial development without adequate environmental safeguards, and sheer greed. Fortunately, public concern, rooted in the country's past, has revived. Major pollutants and critically affected areas have been identified. Pollution control of water, air, and land has been established by both official and private organizations and the work on environmental protection is steadily growing. The Ganga purification plan is a representative case study. Poverty alleviation is a long-term process. It is India's major problem and is being tackled with help from private enterprise and by international assistance. Simultaneously, environmental protection through pollution control is also receiving administrative and legislative support and fiscal assistance through direct and indirect tax incentives. The country's courts are rendering valuable help to environmentalists by pronouncing far-reaching decisions in public interest litigation. To boost the existing environment protection movement, greater emphasis is urgently needed for environmental education, peoples' participation, population control, and cost effective pollution control measures. (Author's abstract)
W90-09361

LONG RESIDUAL ACTIVITY OF BACILLUSS-PHAERICUS 1593 AGAINST CULEX QUINQUEFASCIATUS LARVAE IN ARTIFICIAL POOLS.
Mahidol Univ., Bangkok (Thailand). Dept. of Biology.
S. Pantuwatana, R. Maneeroj, and E. S. Upatham.
Southeast Asian Journal of Tropical Medicine and Public Health SJTMAK, Vol. 20, No. 3, p 421-427, September 1989. 1 fig, 1 tab, 16 ref.

Descriptors: *Bacillus, *Bacteria, *Biological control, *Insect control, *Larvicides, *Mosquitoes, *Pesticides, Population dynamics, Residual activity, Wastewater.

Organic chemical pesticides have been used to control mosquitoes since 1945 with relatively satisfactory results. However, the development of mosquitoes resistant to the pesticides, coupled with the increasing cost of petroleum based components and concerns over the impact of insecticides on the environment, have lead to attempts to find alternative measures to control mosquito vectors. Recently the effectiveness of using Bacillus sphaericus 1593 as a microbial larvicide against Culex quinquefasciatus was demonstrated in artificial pools. This study examines the residual activity of B. sphaericus 1593 in wastewater from sewage canals under field conditions. The larvicidal activity was found to persist for at least 5 months in artificial wastewater pools. The population of B. sphaericus 1593 varied over time, decreasing as much as 3.47 log (10) colony forming units per ml and increasing as much as 2.92 log (10) colony forming units per ml. This evidence indicates that B. sphaericus 1593 can recycle in wastewater pools and that it is an effective natural pesticide. (Marks-PTT)
W90-09369

CONTROL AND TREATMENT OF COMBINED-SEWER OVERFLOWS.
For primary bibliographic entry see Field 5D.
W90-09375

COMBINED SEWER OVERFLOW PROBLEM: AN OVERVIEW.
Moffa and Associates, Syracuse, NY.
P. E. Moffa.
IN: Control and Treatment of Combined-Sewer Overflows. Van Nostrand Reinhold, New York. 1990. p 1-21, 7 fig, 2 tab, 11 ref.

Descriptors: *Combined sewer overflows, *Path of pollutants, *Storm runoff, *Storm wastewater, *Urban hydrology, *Water pollution sources, *Water quality, Bacteria, Dissolved solids, Industrial wastewater, Monitoring, Municipal wastewater, Regulations, Suspended solids.

Since combined sewer overflow (CSO) structures date back to the first sewer systems, they have taken on many forms, often reflecting a local influence. This is particularly true of sewer regulators. The sewage component of CSOs is the smaller, and certainly the more predictable component that can be typified by the population and industry sewered in an area. The storm runoff component is much more difficult to characterize in that it reflects rainfall patterns, surface phenomena, and the sewer system itself. Because of the quantity of pollutants that can discharge over a relatively short period of time, it becomes necessary to determine the quantity, evaluate the impact, and abate the pollution over this period; the peak rate of flow during this period significantly influences the basis of design and related costs of abatement. The demand for monitoring has resulted in the development of a variety of portable and fixed-flow meters and samplers. While early samplers were of the composite type, discrete or sequential samplers were essential for the definition of first-flush effects. It is generally recognized that the final measure of successful abatement is the receiving water quality. The storm runoff component results in such high volumes, depending on the type of storm targeted for abatement, that a receiving water and cost-benefit analysis becomes necessary. Regulatory agencies have generally agreed on the need for site-specific solutions that may require adopting water quality criteria specific to stormwater occurrences. It was not until data from several comprehensive municipal CSO studies were collected that the engineering community began to realize the types of pollutants discharge by overflow systems and their relative impacts on receiving waters. Initial concerns focused not only on the domestic pollutants (bacteria and dissolved oxygen) associated with municipal systems, but on the variety of industrial wastes that discharge to these systems via street runoff that could contain oils, greases, heavy metals, and a wide assortment of other materials. Stormwater regulations were published in December 1988 that, as of this writing, only a few states have adopted. These include: New York

and Massachusetts. (See also W90-09375) (Lantz-PTT)
W90-09376

RECEIVING-WATER IMPACTS.
Limno-Tech, Inc., Ann Arbor, MI.
P. L. Freedman, and J. K. Marr.
IN: Control and Treatment of Combined-Sewer Overflows. Van Nostrand Reinhold, New York. 1990. p 79-117, 15 fig, 3 tab, 31 ref.

Descriptors: *Combined sewer overflows, *Model studies, *Monitoring, *Receiving waters, *Urban hydrology, *Water pollution control, Case studies, District of Columbia, Maumee, New York, Ohio, Onondaga Lake, Perrysburg, Poughkeepsie, Public health, Water quality.

The primary impetus for the control of combined sewer overflow (CSO) is to protect the quality of receiving waters. Therefore, any CSO control program and each different alternative must be evaluated in terms of how it reduces receiving water problems and restores or maintains a beneficial use. CSO impacts and benefits should be evaluated with respect to three basic groups of considerations: water quality changes; public health risks; and aesthetic deterioration. Each consideration affects the value of the receiving water for such uses as recreation, water supply, ecological habitat, and near-shore development. Monitoring is essential to all CSO studies to demonstrate and define the presence of CSO impacts. Modeling provides an additional tool to analyze impacts at nonmonitored conditions. However, models must be based on and confirmed with actual physical, chemical, and biological information. Therefore, monitoring and modeling must be conducted hand-in-hand. The modeling mechanics for streams and rivers are the most simple because the dilutionary flow is well quantified and the direction of flow obvious. CSO impacts on estuaries can often be addressed in a manner similar to stream systems, but with additional complexity due to dispersion, tidal hydraulics, and saline intrusion. If the upper freshwater portion of an estuary is being examined, then simple one-dimensional, intratidal analyses can be appropriate. Analyzing the impacts of CSOs on lakes and impoundments is much different and more complex than for rivers or estuaries. The flow and circulation in lakes is much more varied and complex and the nature of water-quality problems and processes is often different in lakes. As a result, lake analysis usually requires specialized computer modeling programs and comprehensive monitoring programs. The impact of CSOs on river, estuary and lake sediments is a common concern but with no easy means for analysis. Because there are no simple calculations that can be performed to assess these impacts, comprehensive sampling and modeling are typically required. Case examples are provided from Washington, DC., Poughkeepsie, NY, Onondaga Lake, NY, and Perrysville and Maumee Ohio. (See also W90-09375) (Lantz-PTT)
W90-09378

COMBINED SEWER OVERFLOWS: CONTROL AND TREATMENT.
R. Field.
IN: Control and Treatment of Combined-Sewer Overflows. Van Nostrand Reinhold, New York. 1990. p 119-189, 20 fig, 39 tab, 71 ref.

Descriptors: *Combined sewer overflows, *Storm water management, *Storm-overflow sewers, *Urban hydrology, *Wastewater treatment, *Water quality control, Biological treatment, Chemical treatment, Disinfection, Physical treatment, Storage, Storm wastewater.

The control and treatment of combined sewer overflows (CSO) was surveyed in an area encompassing the US EPA's Storm and Combined Sewer Pollution Control Program's research efforts over a 20-year period beginning in the middle 1960s. Because of the similarities in the quantity and quality characteristics of separate storm flows, and the fact that surface runoff phenomenon is the same for separately sewered areas, much of the technology presented in this chapter for CSO ap-

plies to separate urban storm flow as well. The survey was prepared to assist federal, state, and municipal agencies, and private consultants, in facilities planning and design. The discussions of control/treatment technologies that consist mostly of downstream treatment have been divided into seven sections: (1) source control--street sweeping; (2) collection system control; (3) storage; (4) physical (with/without) chemical treatment; (5) biological treatment; (6) advanced treatment; and (7) disinfection. Storage is the oldest documented CSO abatement measure currently practiced, and it should be considered at all times in system planning because it allows for maximum use of existing dry-weather facilities. Physical (with/without) chemical treatment will generally be the minimum required to meet discharge or receiving water quality goals. If a higher degree of organics removal is needed, biological treatment should be examined. If maintaining a viable microorganism population is not feasible, but removal of dissolved and colloidal organics is desired, advanced treatment may be attractive. If disinfection is required, it would follow some level of physical treatment. (See also W90-09375) (Lantz-PTT)
W90-09379

COST-EFFECTIVE ANALYSIS.
Moffa and Associates, Syracuse, NY.
For primary bibliographic entry see Field 6C.
W90-09380

METALS SPECIATION, SEPARATION, AND RECOVERY. VOLUME II.
For primary bibliographic entry see Field 5B.
W90-09381

METALS CONTROL TECHNOLOGY: PAST, PRESENT AND FUTURE.
Illinois Inst. of Tech., Chicago.
For primary bibliographic entry see Field 5D.
W90-09383

RESULTS OF BENCH-SCALE RESEARCH EFFORTS TO WASH CONTAMINATED SOILS AT BATTERY-RECYCLING FACILITIES.
PEI Associates, Inc., Cincinnati, OH.
J. L. Hessling, M. P. Esposito, R. P. Traver, and R. H. Snow.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 497-511, 2 fig, 5 tab.

Descriptors: *Cleanup, *Decontamination, *Industrial wastes, *Lead, *Site remediation, *Soil contamination, *Urban hydrology, Chelation, Hazardous wastes, Heavy metals, Physical treatment, Soil washing.

Soil and debris contaminated by lead (Pb) and other heavy metals are problems at many hazardous waste sites where metal recycling and reclamation activities have been conducted. Piles of spent battery casings as well as slag and dust from furnace operations are often found at such sites. Soil contamination at these sites can typically reach levels in the hundreds and thousands of parts per million (mg/kg) metals. Soil washing can be an effective means of either cleansing the soil or reducing the volume of contaminated solids that ultimately must be treated or disposed. Specific technologies centering on the use of fluosilicic acid, electrowinning, and recovery/recycle of lead-enriched soil fractions for reprocessing in secondary lead smelters are being evaluated and demonstrated. In this partial analysis of the results of these bench-scale studies, the results available at this time indicate that soils from battery-recycling operations in general are not highly responsive to soil washing under the types of contact and washing conditions included in these experiments. Total Pb contamination was virtually unchanged in several of the soil residues after treatment, separation, and rinsing. At best, some portions of some soils showed reductions on the order of 50-80% in total Pb concentrations compared with the untreated

soils; however, even with such reductions, the total amount of Pb remaining in the residues was often still very high (hundreds to thousands of mg/kg). Generally, plain tap water was least effective as a washing medium. The addition of a surfactant to the water produced marginal improvement, and the addition of a chelate showed even further promise as a washing aid, based on the increased concentrations of Pb in the spent wash waters. (See also W90-09381) (Lantz-PTT)
W90-09403

APPLICATION OF CONFLICT ANALYSIS IN DETERMINING ACID RAIN ABATEMENT STRATEGIES.
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W90-09412

ACID RAIN CONTROL STRATEGIES FROM MULTIPLE LONG-RANGE TRANSPORT MODELS.
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
J. H. Ellis.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 37-44, 3 fig, 17 ref.

Descriptors: *Acid rain effects, *Management planning, *Model studies, *Water pollution prevention, *Water pollution sources, Evaluation, Path of pollutants, Statistical analysis, Stochastic models.

Two methods have been developed for incorporating the outputs from multiple long range transport (LRT) simulation models into optimization models for acid rain control. The explicit stochastic model used chance constrained techniques, and proved to be a convenient means for utilizing multiple transfer coefficient realizations. It suffers, however, from the drawback that with only a limited number of transport estimates (one per LRT model), estimation of the required joint density for transfer coefficients is difficult and statistically fragile. Alternatively, the regret-based strategies have, at least surficially, fewer statistical ambiguities, notwithstanding the continuing problem of not knowing the relative probabilities of occurrence of each of the LRT models. Strategies that minimize maximum violations and the important variants, also minimize maximum violation regret, and to a certain extent avoid inter-model distributional complications (and therefore may be preferable), but they clearly do exact a price in control program conservatism. (See also W90-09408) (Lantz-PTT)
W90-09413

ATMOSPHERIC DEPOSITION AND THE CO-EFFICIENT OF NUTRIENT LEACHING (LE DEPOSITION ATMOSPHERIQUE ET LE CO-EFFICIENT DE LESSIVAGE DES NUTRIENTS).
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary). Inst. for Hydraulic Engineering.
J. Deri.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 183-1189, 2 fig, 2 tab, 14 ref. English summary.

Descriptors: *Acid rain, *Forest watersheds, *Leaching, *Nutrients, *Path of pollutants, *Vegetation effects, *Water quality, Air pollution, Correlation coefficient, Flow rates, Monitoring, Nitrogen, Phosphorus, Suspended sediments, Vegetation.

Data from regular observations over a 10 year period on the flow rate and major chemical components of water (total nitrogen and phosphorus,

suspended sediment), were compared with data from plant cover parameters (field-, forest-, and meadow/pasture areas) of the catchment, to develop a method for estimating the impact of plant cover changes on the plant nutrient yield. Data from 14 catchments (from 10 to 2600 sq km size) were used in deriving the nonlinear correlations among these variables with correlation coefficients of +0.9. For a particular catchment the nutrient leaching factors were determined in terms of total nitrogen and phosphorus, taking into account the nutrient inputs from wet and dry atmospheric precipitation. The important role of forests in reducing sediment loads and nutrient leaching was demonstrated. (See also W90-09408) (Author's abstract)
W90-09429

TOXICITY TEST PROTOCOL FOR MATURE BIVALVE MUSSELS USING AUTOMATED BIOLOGICAL MONITORING.
Tennessee Technological Univ., Cookeville. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W90-09461

USE OF SOLID-PHASE RESINS IN PESTICIDE MONITORING.
Richmond Univ., VA. Dept. of Biology.
For primary bibliographic entry see Field 5A.
W90-09462

ECONOMIC EFFECTS OF POLICIES TO PREVENT GROUNDWATER CONTAMINATION FROM PESTICIDES: APPLICATION TO THE SOUTHEAST.
Resources for the Future, Inc., Washington, DC. Quality of the Environment Div.
For primary bibliographic entry see Field 6B.
W90-09476

LIABILITY RULES FOR GROUNDWATER PESTICIDE CONTAMINATION.
Georgia Univ., Athens. Dept. of Agricultural Economics.
T. J. Centner.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 527-535, 1 fig, 40 ref.

Descriptors: *Environmental law, *Groundwater pollution, *Legal aspects, *Legislation, *Liability, *Pesticides, *Water pollution control, Agricultural practices, Environmental protection, Federal jurisdiction, Regulations.

Under the applicable laws of most states, persons contaminating groundwater are liable for injuries and damages arising from the contamination regardless of the lack of knowledge or intent to cause injuries. To limit the potential liability of agricultural producers who apply pesticides in compliance with label instructions and applicable law, the American Farm Bureau Federation is advancing a federal proposal that would exempt producers so long as the producer is not negligent, reckless or misusing a chemical. Similar legislation has been proposed for enactment of state law. Adoption of this legislation would change the legal liability standard from strict liability to negligence. Such legislation does not respond to the growing concern about groundwater contamination. If legislatures desire to address existing rules governing liability for ground water contamination, they should consider all of the possible alternative solutions rather than simply adjust liability rules. Modification of entitlements to incorporate pollution charges or marketable water pollution rights may offer superior mechanisms to provide economic incentives to reduce contamination of groundwater. (See also W90-09440) (Lantz-PTT)
W90-09477

PROCEEDINGS OF THE FOCUS CONFERENCE ON EASTERN REGIONAL GROUND WATER ISSUES.

For primary bibliographic entry see Field 2F.
W90-09479

RESULTS OF ON-GOING MONITORING OF THE PERFORMANCE OF A LOW PERMEABILITY CLAY LINER, KEELE VALLEY LANDFILL, MAPLE ONTARIO.
Golder Associates, Mississauga (Ontario).
For primary bibliographic entry see Field 5B.
W90-09486

PRESERVING WATER QUALITY WITHOUT SEWERS: A CASE STUDY OF ON-SITE WASTEWATER DISPOSAL HYDROGEOLOGY.
Shevenell Gallen and Associates, Inc., Portsmouth, NH.
S. B. Shope, R. A. Weimar, and P. M. Williams.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 93-107, 9 fig, 3 tab, 9 ref.

Descriptors: *Geohydrology, *Groundwater movement, *Groundwater pollution, *Groundwater recharge, *Soil disposal fields, *Wastewater disposal, *Water pollution control, Case studies, Computer models, Land disposal, Phosphorus, Pretreatment of wastewater, Simulation analysis.

A 50-acre parcel of land, located in Windham, New Hampshire, was evaluated for suitability of the on-site disposal of up to 6,700 gallons of wastewater per day. In addition, the potential wastewater impacts to the water quality of Cobbetts Pond and methods to mitigate these potential impacts were evaluated. The topographically high area of the site was identified as the most suitable area for siting the leachfield wastewater disposal system. With the aid of a groundwater simulation model, the depth to the water table at the site under springtime (high-recharge) conditions and with various alternative leachfield disposal systems was determined. The results indicate that a trench-type leachfield system constructed on the upper slope of the high area would provide the maximum depth to the water table. Computer simulation results indicate that the depth to groundwater will be greater than four feet with the proposed leachfield system in operation, even when high groundwater recharge conditions occur in the spring, however critical water levels will exist at the toe of the hill. The design, therefore, incorporates a six-foot-thick bed of imported sand at the base of the slope to mitigate the potential for effluent break-out in this area. The phosphorus attenuation capacity of the soil appears to be relatively limited. Therefore, pretreatment of the effluent to reduce phosphorus concentrations, prior to leachfield disposal, is considered necessary to mitigate long-term (15 to 20 year) water quality impacts to Cobbetts Pond. Pretreatment is capable of reducing phosphorus concentration in the system down to 1 mg/L. Based on the soil nutrient uptake testing, the predicted concentration of phosphorus reaching Cobbetts Pond from the pretreated effluent would be 0.5 mg/L, after 17 years of wastewater disposal. Based on an estimated present watershed phosphorus loading rate (perhaps > 400 kg/yr), the calculated increase in the phosphorus loading rate to Cobbetts Pond, due to the discharge of treated effluent from the proposed development, is approximately 1%. (See also W90-09479) (Author's abstract)
W90-09487

HYDROGEOLOGIC CONSIDERATIONS IN THE DESIGN AND OPERATION OF A PCB WASTE CONTAINMENT FACILITY IN LONDON, ONTARIO.
Conestoga-Rovers and Associates, Waterloo (Ontario).
For primary bibliographic entry see Field 5E.
W90-09488

SEPTIC TANK EFFLUENT QUALITY AND DETERGENTS.
Wisconsin Univ., Madison. Water Resources

Center.
For primary bibliographic entry see Field 5D.
W90-09491

NITRATE LOADING METHODOLOGIES FOR SEPTIC SYSTEM PERFORMANCE PREDICTION: STATE OF AN ART.
Gerber (Robert G.), Inc., Freeport, ME.
A. L. Tolman, R. G. Gerber, and C. S. Hebson.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 167-180, 5 fig, 17 ref.

Descriptors: *Groundwater pollution, *Nitrates, *Septic tanks, *Water pollution control, Geohydrology, Groundwater quality, Path of pollutants, Solute transport, Water quality control.

The effect of septic systems on groundwater quality has long been recognized as a 'planned release' of contaminants. The primary goal in system design and siting is to limit these contaminants so as not to interfere with the health of nearby groundwater users. Methods for assessment of the effect of system discharge on groundwater quality have been and are being developed. Some of the simpler methods use mass balance calculation dilution. This study uses and compares methods using groundwater flow theory and contaminant transport, ranging from simple analytical solutions to complex computer-simulated solute transport analyses. Selection of a method depends on the geohydrologic complexity of the area, the strength of the source, and the proximity of groundwater use. Variables that are still not well defined include the source strength, dispersion, nitrification and denitrification reactions, and microbial survival times. Experience suggests that these are variables which should often be evaluated on a site-specific basis, and not tied to a 'magic number', such as those given in plumbing codes which state minimum distances between wells and septic systems. There appear to be ranges that bracket the likely values of these variables. For small, low density developments, an application of generic guidelines is probably appropriate technology. Groundwater quality is increasingly being used as a tool for density reduction in development. For such purposes, general lot size restrictions and well-septic separation distances could replace requirements for geohydrologic evaluations, provided there is a physical basis for the guidelines. (See also W90-09479) (Author's abstract)
W90-09492

CONTROL OF IN-SITU SPILL BIODEGRADATION WITH LYSIMETERS.
Drexel Univ., Philadelphia, PA. Civil Enginering and Environmental Sciences Inst.
K. J. Davis, J. P. Martin, and W. O. Pipes.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 197-212, 5 fig, 20 ref.

Descriptors: *Biodegradation, *Groundwater pollution, *In situ treatment, *Lysimeters, *Water pollution treatment, Aeration zone, Aquifers, Biological treatment, Biomass, Groundwater movement, Percolation, Soil bacteria.

Though customarily used for sampling soil liquid under tension, lysimeters can also be used in the same manner as wells to control hydraulic potential and recover liquids. The goal is cleanup of contaminants retained above the water table that can be mobilized by rainfall percolation or water table movements. This is to be accomplished by accelerating mobilization and biodegradation while preventing loss to underlying aquifers. A laboratory study was conducted which has two components: hydraulic control of the boundaries to isolate the contaminated soil; and process control of the biological activity. The intent is to expose locally obtained bacteria to samples of the contaminated soil moisture in an aboveground, readily managed unit. Following acclimation the problem

is to colonize the contaminated soil with the acclimated microorganisms in an enriched (nutrients, oxygenated) solution, and maintain growth conditions. Optimum combinations would vary depending upon the type and concentration of the contaminant; the media gradation, structure and stratification, and the location of the contaminated zone relative to the water table. Characteristics of the hydraulic application methods include: steady flow features and intermittent (dose and drain) flow features. The plan is to establish a baseline with a steady seepage of enriched liquid with a particular contaminant, and determine the optimum flow rate in terms of both degradation and the ability of the lysimeter to intercept depleted percolate. Once the hydraulic characterization of the system is complete, the biodegradation investigation commences. A substrate is applied to the surface and allowed to freely drain while tensiometer readings are recorded. Acclimated biomass is introduced to the system through a shower-like nozzle at the top of the column. Migration is tracked with the tensiometers. Permeant is then collected by the lysimeter and recirculated through the acclimmation bed and the column. (See also W90-09479) (Lantz-PTT) W90-09494

BIOTRANSFORMATION OF BTEX UNDER ANAEROBIC DENITRIFYING CONDITIONS: EVALUATION OF FIELD OBSERVATIONS.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
L. A. Lemon, J. R. Barbaro, and J. F. Barker.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 213-227, 7 fig, 4 tab, 12 ref.

Descriptors: *Benzenes, *Biotransformation, *Denitrification, *Ethylbenzene, *Fate of pollutants, *Groundwater pollution, *Toluene, *Water pollution treatment, *Xylenes, Bacteria, Biodegradation, Biological treatment, Bromides, Monitoring, Nitrates, Path of pollutants, Solute transport.

Gasoline-contacted groundwater containing nitrates and bromides were injected into anaerobic groundwater at Canadian Forces Base Borden, Borden, Ontario, to evaluate the potential for in situ biotransformation of BTEX (benzene, toluene, ethylbenzene, and the xylene isomers) by denitrifying bacteria. A relatively uniform, continuous mixed solute plume was created by repeating injections at one to two week intervals over a period of 107 days. Average injection concentrations for the various solutes were: bromide--257 mg/L; nitrate--338 mg/L; benzene--4770 microg/L; toluene--2590 microg/L; ethylbenzene--374 microg/L; p-xylene--367 microg/L; m-xylene--943 microg/L; and o--xylene-551 microg;L. Behavior of the solute plume has been monitored at selected sampling points of multilevel piezometers positioned downgradient of the injection wells. This plume is moving laterally under natural gradients at a velocity of about 6.25 cm/day. Toluene has almost completely disappeared after 60 days, accompanied by a partial loss of nitrate. Nitrate has been consumed in greater proportion than would be predicted by the stoichiometry of toluene transformation by denitrifying bacteria. All other BTEX components were observed to persist for more than 200 days. Additional multilevel piezometers have been installed to evaluate the fate of these apparently recalcitrant compounds over greater distances and longer time periods. (See also W90-09479) (Author's abstract) W90-09495

DESIGNING A GROUNDWATER EXTRACTION SYSTEM FOR A GEOLOGICALLY COMPLEX, LOW-PERMEABILITY AQUIFER IN SOUTHERN NEW HAMPSHIRE.
Camp, Dresser and McKee, Inc., Boston, MA.
J. Drake.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 229-241, 5 fig.

Descriptors: *Groundwater pollution, *Project planning, *Water pollution management, *Water

pollution treatment, Gravel, Groundwater movement, Hydraulic gradient, New Hampshire, Path of pollutants, Pumping, Sand, Wells.

A hazardous waste disposal facility in New Hampshire was shut down in 1979 and placed on the EPA National Priorities List after evidence of improper waste handling was discovered. The facility is situated on a two layer till formation of very low permeability. Remedial investigations determined that organic contaminants found in the on-site groundwater extended to a sand and gravel deposit underlying the adjacent wetland. Both Federal (EPA) and State of New Hampshire mandates dictate that both off-site and on-site contamination must be addressed. To meet this requirement, the following considerations have been incorporated into the extraction system design: (1) the primary route or organic contamination to the off site wetland and subsurface sand and gravel layer is via surface runoff to the wetland edge, where denser than water contaminants 'sank' to the sand and gravel layer; (2) on-site organic contamination from unlined pits and in areas of leaking containers entered the saturated till and migrated both downgradient toward the wetland as well as vertically downward; (3) additional on-site contamination may have been introduced via a buried concrete tank at the upper elevations of the site; (4) the bedrock aquifer beneath the site and downgradient is contaminated, despite an upward hydraulic gradient and a 60 to 100 ft thick till layer, suggesting injection of contaminants into the on-site bedrock well; and (5) off site till and bedrock discharge to a relatively highly permeable sand and gravel layer beneath the wetland. The recommended contaminant recovery system components will include: onsite shallow collection trenches to mitigate contaminated groundwater at depths < 15 ft; onsite recharge trenches to maintain the hydraulic gradient to the collection trenches; and offsite sand and gravel wells pumped alternatively with offsite bedrock wells. Alternate pumping is necessary to assure no dimunition of flow by reducing the hydraulic gradient between the two separate formations. (See also W90-09479) (Lantz-PTT) W90-09496

GROUNDWATER CUTOFF WALLS: APPLICATION AT HAZARDOUS WASTE SITES.
Conestoga-Rovers and Associates, Waterloo (Ontario).
G. T. Turchan, I. K. Richardson, and A. W. Van Norman.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 243-256, 3 fig, 6 ref.

Descriptors: *Cutoffs, *Groundwater barriers, *Groundwater pollution, *Hazardous waste disposal, *Water pollution control, Disposal sites, Monitoring, Slurry walls, Waste disposal.

Groundwater cutoff walls, utilizing slurry trench methodology, were first constructed in North America during the 1940's. Since that time, several hundred groundwater cutoff walls have been constructed for both temporary and permanent control of seepage into foundations and excavations. In more recent years, groundwater cutoff walls have been used to control the migration of contaminants away from waste disposal sites. The results of engineering case studies at various Superfund sites have demonstrated varying degrees of success in the application of groundwater cutoff walls as part of Site remedies. The use of groundwater cutoff walls has increased in recent years, but the understanding of the effects of contaminants on the integrity of these cutoffs has not developed as rapidly. Standardized designs, construction methodologies and testing methods have not been adopted. The nature of contaminant attack on the physical and hydraulic properties of the cutoff materials is only beginning to be thoroughly understood. Based on currently available information several conclusions can be drawn. These are: (1) slurry walls can be used as an effective containment barrier provided the contaminant concentrations are well below solubility limits; (2) non-aqueous phase liquids (NAPL) will adversely

effect the performance of a slurry wall installation; (3) slurry walls should only be implemented after a site specific testing program has been completed; (4) the integrity of slurry wall installations must be verified by monitoring and testing after installation; and (5) field experience and focused research will provide the information required to standardize methods and develop a better understanding of the behavior of slurry walls at hazardous waste sites. (See also W90-09479) (Lantz-PTT) W90-09497

DEVELOPMENT AND DEMONSTRATION OF AN INTEGRATED APPROACH TO AQUIFER REMEDIATION AT AN ORGANIC CHEMICAL PLANT.
Canviro Consultants Ltd., Waterloo (Ontario).
R. B. Whiffin, and R. J. Rush.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 273-288, 6 fig, 3 tab, 8 ref.

Descriptors: *Chemical industry, *Groundwater pollution, *In situ treatment, *Site remediation, *Water pollution treatment, Adsorption, Aquifer restoration, Groundwater quality, Laboratory methods, Monitoring, Sorption, Water quality control.

An approach to aquifer remediation at the Uniroyal Chemical Manufacturing site in Elmira, New York, has been developed to integrate theoretical predictions with laboratory and field scale testing of both contaminant mobility and treatability as well as numerical simulations of groundwater flow. The key aspects of the laboratory testing methodology are: (1) sorption is inferred based on solute concentration prior to and following equilibration with clean porous media from the site; (2) solution concentrations span the range of groundwater concentrations observed at the site; (3) adsorption is assessed under single contaminant and multicontaminant conditions to assess competitive and/or cosolvent effects; (4) the sensitivity of adsorption to other contaminants present at elevated concentrations in groundwater at the site is assessed by conducting tests with/without the contaminant aniline; and (5) tests are performed under typical in situ groundwater conditions (i.e. 10 C, darkness). Field tests are planned to assess desorption processes using a field scale experiment in the shallow aquifer at the site. Uncontaminated water will be injected in a series of injection wells and withdrawn from a series of withdrawal wells located several meters from the site. Groundwater quality will be monitored at several points in the flow field during the estimated 2 month test. During the test, contaminated groundwater pumped from the subsurface will be discharged to the Uniroyal treatment plant and treated with other process effluent. However, full scale implementation would involve coupling the extraction system with a treatment train developed and optimized specifically for the contaminants present in the groundwater. This test is aimed at demonstrating the applicability of purging at this site as well as to identify any inconsistencies between lab and field scale testing. The results will be used to assess the feasibility of selected aquifer remediation alternatives at a full-scale for the study site. The applicability to similar problems at other contaminated sites will also be evaluated. The results of this project will be presented at a later date. (See also W90-09479) (Lantz-PTT) W90-09499

COMPARISON BETWEEN RI/FS RESULTS AND THE REMEDIAL ACTION IMPLEMENTED AT THE BURNT FLY BOG SITE, NEW JERSEY.
Ebasco Services, Inc., Greensboro, NC.
For primary bibliographic entry see Field 6B.
W90-09500

CHARACTERIZATION AND REMEDIAL ASSESSMENT OF DNAPL PCB OIL IN FRAC-

TURED BEDROCK: A CASE STUDY OF THE SMITHVILLE, ONTARIO SITE.
Golder Associates, Mississauga (Ontario).
T. A. McIelwain, D. W. Jackman, and P. Beukema.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 303-315, 5 fig.

Descriptors: *Cleanup operations, *Dense non-aqueous phase liquids, *Groundwater pollution, *Oil pollution, *Project planning, *Site remediation, Aquifer restoration, Aquifers, Case studies, Ontario, Path of pollutants, Smithville.

In 1978, a private waste management firm was issued a Certificate of Approval from the Ontario Ministry of the Environment (MOE) to operate a polychlorinated biphenyl (PCB) transfer and storage facility at a location in the Niagara Peninsula region of south-central Ontario. Between 1978 and 1985, the site reportedly received about 434,000 L of liquid waste, of which approximately 266,000 L were PCB contaminated wastes. Subsequent to the closure of the site, testing by MOE disclosed the presence of PCB contaminated soil and water in a retention lagoon located near the southeast corner of the site. In 1985, MOE began to investigate the potential for offsite migration of contaminants from the facility. Results to date indicate that there is a definite contaminant plume of DNAPL in both the underlying shallow and deep aquifers. The geohydrological investigations completed to date at the Smithville site have identified a large scale occurrence of bedrock contamination by DNAPL and two separate dissolved phase plumes. The expenditure of considerable time and financial resources will be required to assess the ultimate feasibility of complete remediation. In the interim, the shallow and deep dissolved contaminant plumes identified beneath the site would continue to migrate further downgradient offsite, expanding the scope of the existing problem, unless control measures are implemented. In early 1989 MOE directed the project team to design and implement hydraulic controls to contain the dissolved contaminant plume within the shallow aquifer. The system consists of eight 20 cm diameter pumping wells, each equipped with submersible pumping equipment which maintains the hydraulic head within the aquifer at a designed elevation. The well network creates a hydraulic trap preventing groundwater which contacts the DNAPL from escaping the groundwater sink. The network controls groundwater flow to a point 50 m downgradient from the leading edge of the DNAPL plume. A long-term remedial strategy for the site has not been finalized. However, the long-term strategy includes the elimination at the earliest practical time of the estimated 180,000 L of PCB waste currently in secure storage at the site. (See also W90-09479) (Lantz-PTT)
W90-09501

COMPREHENSIVE SITE REMEDIATION CSR ANCHORED BY BIOREMEDIATION SAVES GROUNDWATER SUPPLY OF SMALL MID ATLANTIC COMMUNITY.
Groundwater Technology, Inc., Chadds Ford, PA.
P. M. Yaniga, F. Aceto, L. Fournier, and C. Matson.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 317-328, 4 fig.

Descriptors: *Aquifers, *Bioremediation, *Cleanup operations, *Gasoline, *Groundwater pollution, *Site remediation, *Water pollution treatment, Aeration zone, Air stripping, Biological treatment, In situ treatment, Rural areas, Vadose zone, Water supply.

The loss of 1000 gallons of gasoline from an underground storage tank at a community maintenance facility proved to be an economic impact that far outstripped the cost of the lost fuel. Like many older communities, the construction and location of service facilities to meet community expansion

grew from an as-needed perspective. The locations of these facilities were based on ease of construction and availability of land. In this case, location resulted in both the fuel storage facility and the community well field both located within a 300-foot radius of each other. The loss of fuel resulted in adsorbed, dissolved, and phase separated organics as well as vapors in the same carbonate aquifer from which the community drew its 1,000,000 gallons of water a day. Shut down of the water supply well field was immediate, requiring the community to buy water from an adjoining community at twice their previous cost. A combined immediate response program, coupled with a comprehensive short range aquifer restoration program (two years), eliminated the dependence on imported water and restored the wells within the impacted aquifer to service. The employed elements of on site/in situ treatment included: (1) Volatilization of adsorbed phase organics above the vadose zone with a soil vent system; (2) Phase separated organic recovery from the aquifer proper using a Scavenger two pump system; (3) Air stripping for removal of dissolved phase organics in the groundwater; and (4) Enhanced Natural Degradation END via native microorganism stimulation to remove residual adsorbed phase organics in the vadose and water saturated zone. (See also W90-09479) (Author's abstract)
W90-09502

ARE GROUND WATER VULNERABILITY CLASSIFICATION SYSTEMS WORKABLE.
BCI Geonetics, Inc., Winslow, ME.
For primary bibliographic entry see Field 6B.
W90-09503

CUMULATIVE IMPACTS OF LAND DEVELOPMENT WITHIN WELLHEAD PROTECTION AREAS: ASSESSMENT AND CONTROL.
Horsley, Witten and Hegemann, Inc., Cambridge, Ma.
For primary bibliographic entry see Field 4C.
W90-09508

APPLICATION OF TREATMENT TECHNIQUES TO SOIL VAPOR EXTRACTION SYSTEMS FOR REMEDIATION OF SOILS IN THE UNSATURATED ZONE.
Levine-Fricke, Inc., Emeryville, CA.
F. G. Moss.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 449-465, 5 fig, 2 tab, 5 ref.

Descriptors: *Cleanup operations, *In situ treatment, *Soil gases, *Vapor extraction, *Water pollution treatment, Aeration zone, Case studies, Groundwater pollution, Site remediation, Soil contamination, Vadose zone.

Extraction of the vapor phase from non-aqueous liquids present in the unsaturated zone has become a practical alternative for remediation of shallow contaminated unsaturated soils. Both active and passive extraction systems are capable of removing soil vapors generated from volatile organic chemical compounds present in the vadose zone. The application of a negative pressure (vacuum) to these soils has become an increasingly popular and efficient method for extraction of chemical contamination from the vadose zone. As a result of the extensive use of such extraction systems, there has been an increased demand for engineered solutions to address the treatment and destruction of the soil vapors collected in this manner. Soil and chemical characteristics are important to the design of any extraction and treatment system for remediation of the vadose zone. Initial site specific testing to establish the air flow rate and chemical mass loading anticipated should be performed prior to selection of a method for treatment of the soil vapor. Several methods are available for treatment, include direct venting to the atmosphere, adsorption with activated carbon, injection into an internal combustion engine, and thermal oxidation by combustion with a suitable enrichment fuel. These treatment applications have been shown to be ef-

fective techniques for the removal of both volatile organic compounds associated with liquid hydrocarbon fuels and chlorinated organic solvents. Several site specific case studies are presented to document the performance of these techniques for use at sites with varied subsurface conditions. (See also W90-09479) (Author's abstract)
W90-09511

HYDROCARBON REMOVAL FROM GROUND WATER-DESIGN CONSIDERATIONS AT LEAKING UNDERGROUND STORAGE TANK SITES.
Stover and Bentley, Inc., Stillwater, OK.
J. A. Thomas, and E. L. Stover.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 467-481, 1 tab, 4 ref.

Descriptors: *Cleanup operations, *Groundwater pollution, *Hydrocarbons, *Underground storage tanks, *Wastewater treatment, *Water pollution treatment, Activated carbon, Adsorption, Biodegradation, Biological treatment, Case studies, Leaking, Water pollution sources.

When leaking hydrocarbons enter the saturated zone, the withdrawals of contaminated groundwater, either by collection trenches or recovery wells, is often the most cost effective plume containment alternative at leaking underground storage tank sites. Disposal options include reinjection, discharge to existing industrial or public treatment facilities, discharge to surface water, or beneficial use. Treatment of withdrawn water is usually required prior to disposal. Separate treatment facilities are often required due to the volume of water produced and limited treatment capacities in existing facilities. Many concepts for treatment are well established from years of experience in treating industrial wastewaters. Treatment technologies for free product separation, inorganics and heavy metals removal, and dissolved hydrocarbon removal are discussed. Air stripping, activated carbon adsorption, or biological treatment are the most common dissolved hydrocarbon removal processes. However, several design considerations should be evaluated before purchasing off-the-shelf package treatment systems. Years of experience at numerous site restorations have shown that the kinetics of removal efficiency are affected by more than simple textbook Henry's constants, adsorption capacities, or knowledge of biodegradability. The interaction of site-specific water quality characteristics often have a significant impact on hydrocarbon removal efficiency, treatment costs, and ease of system operations. Case histories evaluating contaminant compounds, free product removal, biodegradation, inorganics fouling, removal driving forces, and operations considerations are presented. (See also W90-09479) (Author's abstract)
W90-09512

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

COMPUTER APPLICATIONS IN WATER SUPPLY. VOLUME 2: SYSTEMS OPTIMIZATION AND CONTROL.
For primary bibliographic entry see Field 5F.
W90-08799

TELEMETRY SYSTEM CONTROL: THE RTK KERNEL--A GENERAL SOLUTION.
Information Processing Ltd., Bath (England).
For primary bibliographic entry see Field 5F.
W90-08801

OPERATIONS CONTROL SYSTEMS IN THE WATER INDUSTRY: WHAT, HOW, AND WHERE TO.
Holloway Associates, Weybridge (England).

Field 6—WATER RESOURCES PLANNING

Group 6A—Techniques Of Planning

For primary bibliographic entry see Field 5F.
W90-08804

REVIEW OF METHODOLOGIES FOR MOD-ELLING AND CONTROL OF WATER SUPPLY.
Leicester Polytechnic (England). Water Control Unit.
For primary bibliographic entry see Field 5F.
W90-08805

LETTING THE RIVERS RUN: TOWARD A MODEL INSTREAM FLOW PROGRAM.
Montana Dept. of Natural Resources and Conservation, Helena.
M. J. McKinney.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 317-329, 24 ref, append.

Descriptors: *Environmental policy, *Headwaters hydrology, *Instream flow, *Management planning, *Water management, Environmental protection, Model studies, Surface water.

The protection of instream flows has gradually increased since the 'environmental decade' of the 1970's. Today, almost every western state has taken some action to manage instream resources. However, the relative effectiveness of these efforts, along with their propensity to disrupt existing water uses, varies considerably. The purpose of this paper is twofold. Existing strategies for instream flow protection in the West, maintaining existing flows, and increasing flows in dewatered basins, are briefly described. A model for instream flow programs is outlined which points out several basic steps that all states culd follow in managing instream resources. These are: (1) establish an instream resource coordinating committee; (2) define program goals and objectives; (3) review and develop instream flow management tools; (4) identify priority stream reaches and instream values; anad (5) monitor, enforce, and evaluate instream water rights. (See also W90-08822) (Lantz-PTT)
W90-08855

DEVELOPMENT OF OPERATING RULES FOR THE VUOKSI RIVER BASIN.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
D. Korobova, V. Poizner, Y. Oziranskii, Y. Plotkin, and A. Egorov.
Publications of the Water and Environment Research Institute PWEIET, No. 3, p 5-16, 1989. 5 fig, 9 tab, 8 ref.

Descriptors: *Finland, *Flood control, *Hydrologic models, *Reservoirs, *Soviet Union, *Uncertainty, *Water resources development, Correlation, Lake Pielinen, Lake Saimaa, Mathematical models, Reservoir operation, Vuoksi River.

A methodology was developed for operation of multipurpose water resource systems under conditions of uncertainty, especially regarding flood and drought periods. For the analysis of water resource systems operation, the multireservoir regulation model developed in the USSR was used. Inflow values of the major lakes of the Vuoksi River Basin were calculated from the outflow and water stage data for years 1941-1954 and 1956-1982. The forecast calculations were made using stepwise regression. As an example, the inflow correlation coefficients of Lake Pielinen (Finland) are presented here. The possibility of using the headwater lakes for flood control of Lake Saimaa (Finland) was investigated. The results show that the multireservoir model can be used for studying the effect of different operational alternatives and for getting a good knowledge of river system behavior. Floods can be best controlled by regulating Lake Saimaa, but in severe flood situations the headwater lakes may be used to minimize damage. (Author's abstract)
W90-09027

MODEL OF COMBINED WATER USE AND WATER DERIVATION PLANNING.

Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
A. Kocharian, and I. Khranovich.
Publications of the Water and Environment Research Institute PWEIET, No. 3, p 27-32, 1989. 4 ref.

Descriptors: *Management planning, *Network design, *Water resources development, *Water resources management, *Water sources, *Water use, Hydrologic models, Mathematical models, Optimization, Reservoirs, Water quality control.

A flow model is presented that describes the selection of optimum parameters of water resource system (WRS) elements: sources of water and pollutants, water reservoirs, reaches of rivers and canals, water users, and water protection facilities. Both water use and water quality control are accounted for in the proposed WRS model. A WRS is considered to be a network with a configuration corresponding to a diagram of the WRS. All assumed WRS elements, existing or possible, are represented. Elements of the network have their own characteristics and their interaction is produced by flow movement, corresponding to water and admixture flows in the simulated system. For any WRS element a finite set of possible development alternatives is defined. Each of them is characterized by a set of element parameters. In the model, every version of WRS elements' development is presented as an operational element. Continuity equations, resource constraints, and development of the model (development task) are described mathematically here, including a discussion of how optimum WRS parameters are to be selected. (Rochester-PTT)
W90-09029

BIOTRANSFORMATION OF CONTAMINANTS IN GROUND WATER.
For primary bibliographic entry see Field 2F.
W90-09069

GROUND WATER CLEANUPS AND STANDARDS.
For primary bibliographic entry see Field 2F.
W90-09070

HOW CLEAN IS CLEAN: A FIELD PERSPECTIVE.
For primary bibliographic entry see Field 5G.
W90-09071

WASTE SITE REMEDIATION TECHNOLOGY.
For primary bibliographic entry see Field 5G.
W90-09077

IMPACT OF CLIMATE CHANGE ON COASTAL ZONE MANAGEMENT IN BRITAIN: A PRELIMINARY ANALYSIS.
Middlesex Polytechnic, London (England). Flood Hazard Research Centre.
For primary bibliographic entry see Field 2A.
W90-09099

IMPACTS OF CLIMATE VARIABILITY AND CHANGE ON URBAN AND INDUSTRIAL WATER SUPPLY AND WASTEWATER DISPOSAL.
International Inst. for Applied Systems Analysis, Laxenburg (Austria).
For primary bibliographic entry see Field 2A.
W90-09100

IDENTIFYING THE CLIMATE-SENSITIVE SEGMENT OF BRITISH RESERVOIR YIELD.
Institute of Hydrology, Wallingford (England). Engineering Hydrology Div.
For primary bibliographic entry see Field 2A.
W90-09101

ANTHROPOGENIC CHANGES OF CLIMATE, WATER RESOURCES AND WATER MANAGEMENT PROBLEMS.

Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR).
For primary bibliographic entry see Field 2A.
W90-09108

ASSESSMENT OF CLIMATIC CHANGES IMPACTS ON WATER RESOURCES MANAGEMENT IN AN IRRIGATED ZONE.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2B.
W90-09111

COMPUTER-AIDED PLANNING FOR MULTIPLE-PURPOSE RESERVOIR OPERATING POLICIES.
Colorado Univ. at Denver. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4A.
W90-09354

STATE WATER PLANNING: A FORUM FOR PROACTIVELY RESOLVING WATER POLICY DISPUTES.
Montana Dept. of Natural Resources and Conservation, Helena. Water Resources Div.
M. J. McKinney.
Water Resources Bulletin WARBAQ, Vol. 26, No. 2, p 323-331, April 1990. 36 ref.

Descriptors: *Montana, *Planning, *Water policy, *Water resources, Decision making, Public policy.

In the arid West, the development and implementation of water policy often results in disputes among water users, resource managers, and policy makers. Although significant attempts have been made to improve public involvement and dispute resolution in water resources planning, the traditional planning process has not historically played this role for a variety of reasons. Water resources planning can become a forum for proactively resolving water policy disputes by employing the principles of environmental dispute resolution. The role of collaborative, consensus-building planning processes in resolving water policy disputes was explored. The Montana State Water Plan was evaluated as an example of such a process. A model state water planning process is outlined and contains the following steps: initiation, process design, mutual education, problem definition and analysis, option generation, option evaluation, decision making, and implementation. (Peters-PTT)
W90-09356

CONTROL AND TREATMENT OF COMBINED-SEWER OVERFLOWS.
For primary bibliographic entry see Field 5D.
W90-09375

COMBINED SEWER OVERFLOWS: CONTROL AND TREATMENT.
For primary bibliographic entry see Field 5G.
W90-09379

METRO RECOVERY SYSTEMS--A CENTRALIZED METALS RECOVERY AND TREATMENT FACILITY IN TWIN CITIES, U.S.A.
Lancy International, Inc., Warrendale, PA.
For primary bibliographic entry see Field 5D.
W90-09405

APPLICATION OF CONFLICT ANALYSIS IN DETERMINING ACID RAIN ABATEMENT STRATEGIES.
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
E. A. McBean, N. Okada, K. Hipel, and T. Unny.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 27-35, 4 tab, 15 ref.

Descriptors: *Acid rain, *Canada, *Decision making, *Management planning, *Water pollution prevention, Air pollution, Metagame theory, Policy making, Political aspects, Water quality.

While the genesis of the acid rain problem is in a large measure scientific, its solution is greatly influenced by political considerations. One method for examining the problem further is to utilize a multi-player game that can identify problems which are viable from both technological and political viewpoints. Metagame analysis is a game-theoretic technique used for the analysis of political problems. The major decision-making parties in the game are called 'players'. The intent of the 'game' structure is to determine equilibrium positions of the players involved, where these positions are interpreted as politically feasible outcomes. The application of metagame discussed here considers only the Canadian players in the solution of the acid rain problem. The players are: (1) the Canadian government--wants to clean up the problem and would like to do so at a minimum cost; and (2) Emissions sources--including both the power and resources manufacturing sectors. The options available to the Canadian government players include: (1) regulation by decree for full abatement, noted as 'RD (for FA)'--the government dictates emission levels which must not be exceeded, implying full abatement; (2) regulation by decree noted as 'RD (for PA), the government dictates emission levels implying abatement only; and (3) regulation by subsidy, noted as 'RS', the government introduces incentives, such as tax breaks or grants, to offset the costs of abatement measures undertaken by the emission sources, only if abatement is to the full abatement (FA) level. Emissions sources options include: (1) full abatement; (2) partial abatement; and (3) decrease production to meet the required emission levels. The next stage of the analysis is to examine the stability of each outcome for each player. A unilateral improvement (UI) consists of changes in a player's strategy which result in a more preferred outcome for the player from the outcome under consideration, assuming that the strategies of the other players remain unchanged. The outcome is 'rational' if the player has no UI's he/she can make from the outcome. Potential equilibrium solutions are then formulated. (See also W90-09408) (Lantz-PTT)
W90-09412

ACID RAIN CONTROL STRATEGIES FROM MULTIPLE LONG-RANGE TRANSPORT MODELS.
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
For primary bibliographic entry see Field 5G.
W90-09413

MODELLING AGRICULTURAL PESTICIDE APPLICATION AND RISK FOR THE CHESAPEAKE BAY REGION OF VIRGINIA: CURRENT ESTIMATES, FUTURE TRENDS AND RESEARCH NEEDS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics.
S. Phillips, and L. Shabman.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 536-548, 5 tab, 21 ref.

Descriptors: *Agricultural chemicals, *Chesapeake Bay, *Management planning, *Model studies, *Pesticides, *Research priorities, *Risk assessment, *Water pollution effects, *Water quality trends, Agricultural practices, Future planning, Land use, Toxicity, Virginia, Water quality.

In the Chesapeake Bay region, concern over the potential effects of toxic chemicals on the Bay has revealed that there is a lack of information on the amount and type of pesticide use in the Bay basin. Consequently, a model of current and potential future agricultural pesticide use in eastern Virginia counties is being developed. As part of the model, a combination of available secondary data and primary information solicited from agricultural production specialists was used to estimate current

herbicide, fungicide and insecticide use on all production systems, including land extensive row-crop production and more land intensive fruit, vegetable and nursery production. Total application volume was estimated in three categories of toxicity to fish and wildlife; non-toxic, toxic but short-lived, and toxic and persistent. Future scenarios for agricultural land use and production practices in east Virginia were also examined. Particular consideration was given to the possibilities of reductions in land-extensive row crop acreage, increases in land-intensive horticultural crop production, and wider adoption of low-input production technology. These scenarios will be used to consider how the water quality problems posed by agricultural pesticides may change with time. The model also allows potential changes in chemical use to be driven by changes in land use or chemical use alone, or a combination of land and chemical use changes. (See also W90-09440) (Lantz-PTT)
W90-09478

RISK BASED DECISION MAKING PROCESS FOR THE SELECTION OF SANITARY LANDFILLS: 'THE POLITICAL REALTY'.
Trow, Dames and Moore, Mississauga (Ontario). Waste Management and Environment Div.
J. A. Beechinor.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 123-136, 3 fig, 23 ref.

Descriptors: *Decision making, *Sanitary landfills, *Site selection, *Waste disposal, Geohydrology, Landfills, Management planning, Ontario, Political aspects, Risk assessment, Waste management.

In Ontario, most municipalities must wrestle with the very difficult job of siting new sanitary landfill operations. The process of selecting acceptable landfill sites is complex involving political, social and technical considerations. Proponents find that the credibility of the decision making process is often suspect and the assignment of environmental and public health risks uncertain. This paper offers an improved decision making framework, involving risk assessment, for the selection of sanitary landfill sites. The framework considers the geohydrological perspective in which the environmental concern is the means and mechanism by which hazardous materials are transported and distributed by groundwater. Underlying the decision making framework is the knowledge that individual perceptions and the resulting preferences with respect to defining the acceptable level of risk cannot be aggregated. Consequently, the siting principles and goals must be established through the process of gaming, so that an agreement among interested parties is obtained. (See also W90-09479) (Author's abstract)
W90-09489

CHARACTERIZATION AND REMEDIAL ASSESSMENT OF DNAPL PCB OIL IN FRACTURED BEDROCK: A CASE STUDY OF THE SMITHVILLE, ONTARIO SITE.
Golder Associates, Mississauga (Ontario).
For primary bibliographic entry see Field 5G.
W90-09501

6B. Evaluation Process

APPLICATIONS REVIEW OF MODELLING AND CONTROL OF WATER SUPPLY AND DISTRIBUTION SYSTEMS.
Leicester Polytechnic (England). Water Control Unit.
For primary bibliographic entry see Field 5F.
W90-08808

REAL-TIME FORECASTING AND CONTROL FOR WATER DISTRIBUTION.
Heriot-Watt Univ., Edinburgh (Scotland). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W90-08817

OPTIMAL OPERATION OF WATER SYSTEMS.
Sociedad General de Aguas de Barcelona (Spain).
For primary bibliographic entry see Field 5F.
W90-08818

OPTIMAL CONTROL OF THE WEST PARISIAN AREA WATER SUPPLY NETWORK.
Lyonnaise des Eaux, Paris (France).
For primary bibliographic entry see Field 5F.
W90-08819

COMPUTER CONTROL OF WATER SUPPLY AND DISTRIBUTION SYSTEMS: STRUCTURES, ALGORITHMS AND MANAGEMENT.
Leicester Polytechnic (England). Water Control Unit.
For primary bibliographic entry see Field 5F.
W90-08820

DISTRIBUTION SYSTEM MANAGEMENT AND CONTROL OPTIMISATION.
North Surrey Water Co., Staines (England).
For primary bibliographic entry see Field 5F.
W90-08821

EVALUATING A BANK STABILIZATION PROJECT 25 YEARS AFTER COMPLETION.
White Mountain National Forest, Laconia, NH.
For primary bibliographic entry see Field 4D.
W90-08832

CRITERIA FOR EVALUATING INSTREAM FLOW PROGRAMS: DECIDING WHAT WORKS.
National Ecology Research Center, Fort Collins, Co.
B. L. Lamb, and H. R. Doerksen.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 299-305, 1 tab, 10 ref.

Descriptors: *Flow control, *Headwaters hydrology, *Instream flow, *Management planning, Costs, Decision making, Evaluation, Public policy, Water management.

In establishing instream flow policy, government jurisdictions have adopted numerous approaches. Approaches are discussed in order to help policy makers decide what works. The objective is to promote secure protection at moderate cost. Various criteria for evaluating instream flow programs are presented, including stream miles protected, quality of protection offered, and security of flow levels. For each criteria, possibilities and pitfalls are highlighted. Judgement about the soundness of a particular program should begin with a clear set of objectives. The suggestion that emerges from such a brief analysis can only be to rely on some combination of these measures. (See also W90-08822) (Lantz-PTT)
W90-08853

HYDROLOGIC SIMULATION TECHNIQUES APPLIED TO WATER MANAGEMENT IN MONTANA.
Montana Dept. of Natural Resources and Conservation, Helena.
For primary bibliographic entry see Field 2E.
W90-08882

STOCHASTIC MODELING OF LAKE LEVELS FOR A MANAGEMENT DECISION.
Forest Service, Washington, DC.
For primary bibliographic entry see Field 2H.
W90-08885

COMPREHENSIVE COUNTY WATER PLANNING PROCESS IN SOUTH CENTRAL MINNESOTA.
Mankato State Univ., MN. Dept. of Biological Sciences.

Group 6B—Evaluation Process

H. W. Quade, and R. A. Barrett.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 149-153, Fall 1989. 1 tab, 5 ref.

Descriptors: *Comprehensive planning, *Minnesota, *Regional planning, *Water resources management, Governmental interrelations, Public policy.

Development of county comprehensive water plans is underway in a majority of Minnesota counties as a result of recent legislation. The planning process requires the fashioning of new relationships and roles for local and state government, agency personnel, and interdisciplinary technical teams. Early water planning efforts reveal significant problems with the adequacy and applicability of existing water resources data. Assessment of citizen attitudes regarding water resource issues was found necessary to link support with policy and develop public education activities. Analysis of water resources data combined with citizen and state agency attitudes has enabled counties in south central Minnesota to formulate goals and objectives for their county plans. County water resources management committees are currently formalizing strategies and implementation models to effectuate plan goals and objectives. The process of developing county comprehensive water plans in south central Minnesota has led to the preliminary conclusion that the process will become ongoing after plans are first adopted and that the relationships of local government, state agencies and technical professionals will evolve into a more constructive partnership for the benefit of water resources. (Author's abstract)
W90-08993

RISK CALCULATION AS A STANDARD FOR CLEANUP.
J. H. Highland.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 235-242.

Descriptors: *Cleanup, *Groundwater pollution, *Groundwater quality, *Legislation, *Risk assessment, *Water pollution treatment, *Water quality management, Environmental protection, New Jersey, Population exposure, Public health, Site remediation, Water quality standards.

In issues relating to groundwater contamination and the issue of 'how clean is clean,' the distinction between cure and protection is an important one. The need to find a cure arises where there are Superfund sites or other hazardous waste disposal sites which are the focus of attention and where a responsible party or government agency is seeking to do a cleanup. In New Jersey, there is a law called the Environmental Cleanup Responsibility Act (ECRA), which requires that certain industrial facilities (mainly manufacturing facilities) which have handled, stored, disposed of, or treated any hazardous substance (not waste) undergo a review prior to the sale of the property. At such sites many sources of contamination are found, such as industrial sewers, underground tank valves, and pipes that have carried materials. The standard of care applied to groundwater is 'clean it up to background,' which requires definition of what is background. Groundwater and soil contamination are linked; the 'how clean is clean' issue not only involves the groundwater but relates to the soil source as well. Some responses to contamination are: to have an alternative water supply in order to protect public health; to cleanup to background, but to accept that anything that is present or a result of industrial activity is a separate issue; set standards for groundwater; or an approach called a health and environmental base standard of care, which takes into account the inherent hazard of the materials which are present, the potential for exposure that exists for receptors given this groundwater contamination, and an evaluation of the risk that would result from that exposure. Risk calculation is important, since it allows for some consideration of site-specific factors as well as for differences in the inherent toxicological properties of materials. This method has met with objections from regulators, because to do a health risk analysis and do it properly is time-consuming and takes a lot of money. As an alternative, the elements of risk analysis can be used and a one-time analysis done on a conservative basis. This can be done where the inherent hazardous materials are set forth, certain exposure pathways are designated, and certain standards are set based on the assumptions used in the health risk analysis. (See also W90-09063) (Fish-PTT)
W90-09073

GROUND WATER CLASSIFICATION: A STATE PERSPECTIVE.
For primary bibliographic entry see Field 2F.
W90-09082

GROUND WATER CLASSIFICATION.
For primary bibliographic entry see Field 2F.
W90-09083

RESOURCE PROTECTION VS. SOURCE CONTROL STRATEGIES.
H. F. Elkin.
IN: Ground Water Contamination: Sources, Effects and Options to Deal with the Problem. The Proceedings of the Third National Water Conference, January 13-15, 1987. Philadelphia, Pennsylvania. The Academy of Natural Sciences, Philadelphia, Pennsylvania. (1987). p 405-411.

Descriptors: *Groundwater pollution, *Groundwater quality, *Management planning, *Water pollution control, *Water quality management, Classification, Environmental protection, Governmental interrelations, Land use, Policy making, Public health, Regulations, Water pollution prevention.

The current national policy dialog on groundwater protection needs to address both groundwater protection and contamination prevention in the context of resource-protection versus source control-focused strategies. Historic lessons from experience with other environmental programs should be considered. Resource-based prevention programs include aquifer classification; non-degradation proposals; and land-use and zoning concepts. Source-control techniques include controls on sources, facilities, and activities; management practice requirements; and economic incentives encouraging control implementation. Groundwater resources are invaluable and, at any point in time, irreplaceable and finite. Economic and technological resources are limited, however, and must be managed optimally for a multiplicity of functions and uses. A coordinated mix of prevention strategies, designed both to protect the resource and manage the uses, should be the ultimate goal of a national groundwater protection strategy. (See also W90-09063) (Fish-PTT)
W90-09085

EVALUATING DAM SAFETY RETROFITS WITH UNCERTAIN BENEFITS: THE CASE OF MOHAWK DAM (WALHONDING RIVER, OHIO).
Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Engineering and Public Policy.
For primary bibliographic entry see Field 8A.
W90-09179

EMPLOYEE INVOLVEMENT AND ENVIRONMENTAL EXCELLENCE.
For primary bibliographic entry see Field 5D.
W90-09229

VALUING URBAN WATER ACQUISITION.
Texas A and M Univ., College Station. Dept. of Agricultural Economics.
R. C. Griffin.
Water Resources Bulletin WARBAQ, Vol. 26, No. 2, p 219-225, April 1990. 3 tab, 13 ref.

Descriptors: *Cost-benefit analysis, *Economic aspects, *Management planning, *Municipal water, *Texas, *Water supply development, Available water, Urban areas.

Municipalities typically seek additional water supplies whenever prospective population and economic growth suggests the inadequacy of currently available water supply. The benefit of supply enhancement is usually construed as avoiding debilitating water scarcity. A more effective approach to planning is to compare the benefits and costs of supply augmentation. The net present value of benefits for a supply increase in a representative Texas community was calculated for alternative scenarios relating to population growth, rate growth, and the temporal distribution of the increased supply. Consumer surplus measures are sensitive to all three of these factors and vary from $0 to > $4000/ acre-foot. A notable finding is that the added supply may offer zero values in cases where real water prices increase at an annualized rate of 4% (or greater) which is half the rate occurring in Texas from 1981-1985. (Author's abstract)
W90-09345

COMPUTER-AIDED PLANNING FOR MULTI-PLE-PURPOSE RESERVOIR OPERATING POLICIES.
Colorado Univ. at Denver. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4A.
W90-09354

ECONOMIC EFFECTS OF POLICIES TO PREVENT GROUNDWATER CONTAMINATION FROM PESTICIDES: APPLICATION TO THE SOUTHEAST.
Resources for the Future, Inc., Washington, DC. Quality of the Environment Div.
L. P. Gianessi, R. J. Kopp, and C. A. Puffer.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 517-526, 5 tab, 13 ref.

Descriptors: *Economic aspects, *Environmental policy, *Groundwater pollution, *Groundwater quality, *Management planning, *Pesticides, *Water pollution management, *Water quality control, Agriculture, Environmental protection, Leaching, Risk assessment.

Policies to prevent groundwater contamination from pesticides are likely to result in restrictions on the use of highly soluble active ingredients in areas where the ground water is vulnerable to the leaching of chemicals from the surface. A large number of counties in the Southeast are potentially vulnerable to groundwater contamination from pesticides. A The economic consequences of banning the use of certain soluble active ingredients in pesticides currently used for crops grown in the Southeast where there is high groundwater vulnerability are summarized. Groundwater protection strategies are likely to have an uneven impact on agriculture throughout the country. The extent of groundwater vulnerability varies regionally. Since bans are likely to be targeted to individual counties, detailed, county-level information will be required if these policies are to be assessed. (See also W90-09440) (Lantz-PTT)
W90-09476

COMPARISON BETWEEN RI/FS RESULTS AND THE REMEDIAL ACTION IMPLEMENTED AT THE BURNT FLY BOG SITE, NEW JERSEY.
Ebasco Services, Inc., Greensboro, NC.
D. J. Green, M. P. Maley, G. Maurath, and C. H. Swan.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 289-301, 6 fig, 1 tab, 2 ref.

Descriptors: *Burnt Fly Bog Site, *Cleanup operations, *Feasibility studies, *Site remediation, *Water pollution treatment, Environmental policy, Monitoring, Monmouth, New Jersey, Quality control.

Many hazardous waste sites have undergone Remedial Investigation/Feasibility Studies (RI/FS). However, comparatively few sites have undergone remedial action. Therefore, it is difficult to evaluate whether initial studies are providing the most appropriate, targeted data necessary to design and implement effective remedial actions. The Uplands Area of the Burnt Fly Bog Site in Monmouth County, New Jersey, is currently being cleaned up. These remedial activities have relied extensively on a database developed from information collected during both preliminary field investigations and clean-up operations. A comparison of the results of these studies, and the actual conditions encountered during remediation, allows for the evaluation of accepted practices for investigations at hazardous waste sites. Extensive sampling during site clean-up provided more data on the extent and distribution of contamination and also provided quality assurance documentation of remediation activities. Initial evaluations indicate that a more balanced sampling program, in terms of sample number, distribution, and type of analyses, yields an improved technical understanding of a hazardous waste site. Since detailed sampling will be required for most remedial actions, the collection and analysis of fewer, more targeted samples during site characterization studies can be justified as technically feasible and cost effective. (See also W90-09479) (Author's abstract)
W90-09500

COMPREHENSIVE SITE REMEDIATION CSR ANCHORED BY BIOREMEDIATION SAVES GROUNDWATER SUPPLY OF SMALL MID ATLANTIC COMMUNITY.
Groundwater Technology, Inc., Chadds Ford, PA.
For primary bibliographic entry see Field 5G.
W90-09502

ARE GROUND WATER VULNERABILITY CLASSIFICATION SYSTEMS WORKABLE.
BCI Geonetics, Inc., Winslow, ME.
P. Garrett, J. S. Williams, C. F. Rossoll, and A. L. Tolman.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 329-343, 3 fig, 4 tab, 19 ref.

Descriptors: *Classification, *Groundwater pollution, *Water pollution control, Aquifers, DRASTIC, Geohydrology, Groundwater recharge, Maine, Path of pollutants, Permeability, Water pollution sources, Water quality management.

The State of Maine evaluated both DRASTIC (a standardized method for evaluating groundwater pollution potential using geohydrologic settings) and a custom modified system to see if either could map groundwater vulnerability. The two systems were tested at known sites of groundwater contamination to determine the correlation between actual contamination and 'vulnerability'. A poor correlation was found for both systems. One reason for this seems to be that the fractured bedrock aquifer is more vulnerable than sand and gravel, as demonstrated in several independent investigations. Therefore, although a vulnerability classification systems may be useful for certain specific purposes, multi-purpose classification systems are too full of unidentified uncertainties to be useful for local decision-making, where most land use decisions are made. Other problems with vulnerability classification systems are: (1) the DRASTIC method assumes that a contaminant, with the mobility of water, is introduced at the surface; (2) both DRASTIC and the Maine Modified rating schemes assign low scores to deep water tables and high scores to permeable soils and surficial deposits. In Maine's climate, however, deep water tables are only possiable with permeable soils. Where deep water tables to occur in permeable deposits, the scores tend to counter each other. This tends to bring scores into a middle range without much discriminating power. Similarly, clays are generally recognized as low vulnerability deposits; (3) recharge versus discharge was not considered as one of the DRASTIC factors, because natural discharge can easily be revered by pumping from a

well; (4) vulnerability scores are generally assigned by technicians without extensive field experience; and (5) the DRASTIC manual specifically states that the method 'is designed to evaluate groundwater pollution potential from a regional perspective and should be applied to areas 100 acres or larger in size...' This size caveat could lead to the misapplication of the method. (See also W90-09479) (Lantz-PTT)
W90-09503

PAST, PRESENT AND FUTURE OF GROUND-WATER DEVELOPMENT IN THE TRI-CITIES OF KITCHENER, WATERLOO AND CAMBRIDGE ONTARIO, CANADA.
Water and Earth Science Associates Ltd., Carp (Ontario).
For primary bibliographic entry see Field 4B.
W90-09507

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

CONSIDERATIONS FOR REDUCING THE COST OF TESTING DREDGED MATERIAL.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5E.
W90-08755

WATER AND EFFLUENT MANAGEMENT IN INDUSTRY: OBTAINING AND USING INFORMATION TO FACILITATE MEANINGFUL DECISION MAKING.
Council for Scientific and Industrial Research, Pretoria (South Africa).
For primary bibliographic entry see Field 5G.
W90-08772

EQUITABLE GROUNDWATER MANAGEMENT IN THE TUCSON ACTIVE MANAGEMENT AREA.
Arizona Univ., Tucson. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 4B.
W90-08848

WATER ALLOCATION UNDER A RIPARIAN SYSTEM TAKING INTO ACCOUNT SURFACE AND GROUNDWATER INTERACTIONS--THE CASE OF IRRIGATION DEVELOPMENT IN THE HEADWATERS OF THE SUSQUEHANNA RIVER.
Cornell Univ., Ithaca, NY.
For primary bibliographic entry see Field 6E.
W90-08857

ECONOMIC ANALYSIS OF IRRIGATION SYSTEMS.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 3F.
W90-08954

INTERBASIN WATER TRANSFERS: AN ECONOMIC PANACEA OR A POLITICAL PLOY.
K. W. Easter, and N. Becker.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 154-157, Fall 1989. 1 tab, 12 ref. NOAA Grant no. NA86AA-D-SG112.

Descriptors: *Cost analysis, *Great Lakes, *Interbasin transfers, *Legal aspects, *Water law, Economic aspects, Judicial decisions, Michigan, New York, Ontario, Quebec, Water resources management.

Transferring water over long distances is nothing new for the United States. New concern about the open access nature of the Great Lakes was sparked by the 1982 Sporhase Supreme Court Decision, which limited states' power to prevent interbasin water transfers. Concern was intensified by the 1988 drought in the Midwest, the growing water problems facing the southwestern states, and the

continued shift of the U. S. population to the Sun Belt. In response to the court decision, the Great Lakes Charter was adopted which established a set of management rules for new interbasin water transfers and other consumptive water uses. However, not all Great Lakes states have implemented the Charter provisions and, even if they did, it is not clear that the Charter objectives could be reached. The big losers from a large interbasin water transfer would be hydropower and navigation interests. The states most affected would be New York and Michigan, along with the two Canadian provinces, since they produce and use most of the hydropower on the Great Lakes. It appears that, given the high costs of large interbasin water transfers, they could not be economically justified, particularly those designed to provide irrigation water for the southwestern states. Only small water transfers for urban or industrial uses would have a chance of passing any economic efficiency or political test. (Author's abstract)
W90-08994

IRRIGATION WATER PRICING POLICIES TO REDUCE AND FINANCE SUBSURFACE DRAINAGE DISPOSAL.
Hebrew Univ. of Jerusalem, Rehovoth (Israel). Faculty of Agriculture.
For primary bibliographic entry see Field 3F.
W90-09016

ALLOCATIVE EFFICIENCY IMPLICATIONS OF WATER POLLUTION ABATEMENT COST COMPARISONS.
Pennsylvania State Univ., University Park. Dept. of Agricultural Economics and Rural Sociology.
For primary bibliographic entry see Field 5G.
W90-09153

OPTIMIZATION OF THE PUMPING SCHEDULE IN AQUIFER REMEDIATION UNDER UNCERTAINTY.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 5G.
W90-09162

ECONOMIC POLICIES FOR REGULATING AGRICULTURAL DRAINAGE WATER.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 5G.
W90-09353

COST-EFFECTIVE ANALYSIS.
Moffa and Associates, Syracuse, NY.
P. E. Moffa.
IN: Control and Treatment of Combined-Sewer Overflows. Van Nostrand Reinhold, New York. 1990. p 191-208, 13 fig, 1 tab, 8 ref.

Descriptors: *Combined sewer overflows, *Cost analysis, *Cost-benefit analysis, *Storm-overflow sewers, *Urban hydrology, *Water pollution control, Best management practices, Case studies, Costs, District of Columbia, New York, Onondaga Lake, Water quality management.

When costs are plotted against benefits, the break or the 'knee' of the curve is that point where additional benefits result in more rapidly rising unit costs, or the period beyond where there are diminishing returns. The stormwater and combined sewer overflow (CSO) problem presents a high degree of variability in terms of rate of flow, volume, pollutants discharged, and water quality impact. This has undoubtedly contributed to the indecision by regulatory agencies to come to grips with rules governing CSO abatement. This chapter presents a methodology that focuses on cost-benefit relationships. This approach becomes particularly important in light of the dwindling nature of federal and state monies and the greater reliance on local monies. A method that combines the assumption that certain water quality standards are associated with the protection of water uses and estimates of increased water use potential appears to

be the most effective means of obtaining approvals and funding. Two case studies, one from Onondaga Lake, NY, and another from Washington, DC, are presented to illustrate cost-benefit relationships. A best management practice (BMP) program costing $10 million was conducted on Onondaga Lake, comprised of: (1) cleaning of sewers; (2) raising of weir elevations; and (3) installing backwater gates, which has resulted in a significant reduction of annual loadings to the lake. It has been estimated that as a result of the diversion of such volumes, the annual loading of phosphorus to the lake from CSO discharges has been reduced by > 85%. In Washington, DC, a two-segment abatement program was developed that consists of a mix of both collection system optimization and capital intensive measures. The first segment of the plan consists of: (1) minimal modification of the existing sewage system to maximize conveyance system capacity; (2) a telemetry system to control overflows; and (3) the construction of a 400-million gallon/day end-of-pipe treatment facility near the Robert Kennedy Memorial Stadium for remediation of particular water quality problems in the Anacostia River. This facility consists of three 57-ft diameter swirl concentrators, followed by high-rate disinfection and post-kill neutralization. (See also W90-09375) (Lantz-PTT)
W90-09380

6D. Water Demand

LIFE OF ITS OWN: THE POLITICS AND POWER OF WATER.
California Univ., Los Angeles.
R. Gottlieb.
Harcourt Brace Jovanovich, Publishers, New York. 1988. 332p.

Descriptors: *Political aspects, *Social aspects, *Water demand, *Water policy, *Water rights, Administrative agencies, Federal jurisdiction, Institutional constraints, Public policy, Regulations, Water quality, Water resources development.

This book is an exploration of the players and the issues of the water industry and the social realities they engender. Though the water industry has always been predominantly local in composition, it has thrived in its relationship with Congress and the federal agencies, although those ties, as described in chapter 2, have today become more problematic. Water policy has also been a reflection of the strategies and objectives of the dominant players, particularly agriculture and urban interests--the subjects of the third and fourth chapters. While the players within the water industry maneuver and reposition themselves, they have at the same time been obliged to confront a different set of issues and a growing array of critics of their overall water policies, as the fifth and sixth chapters describe. As concerns regarding new forms of contamination have emerged, the public has shifted its focus to the quality of the water rather than its availability. Water quality has become both an urban and a rural issue, affecting as much industry as municipalities and agriculture. These issues in turn have forced the water industry to contend with differing interpretations of the role and purpose of the water agencies themselves and the policies they pursue. Social movements have sought to address the ways in which these water policies are established and objectives are defined. The water industry has been challenged, and the outcome is still in doubt. (Lantz-PTT)
W90-08747

SOME DYNAMIC DEMAND ASPECTS OF NETWORK ANALYSIS MODELLING.
Ward, Ashcroft and Parkman, Chester (England).
For primary bibliographic entry see Field 5F.
W90-08781

TIME SERIES MODELLING OF WATER DEMAND--A STUDY ON SHORT-TERM AND LONG-TERM PREDICTIONS.
Instituto de Ingenieria Cibernetica, Barcelona (Spain).
For primary bibliographic entry see Field 5F.

W90-08789

APPLICATIONS OF TIME SERIES ANALYSIS TO WATER DEMAND PREDICTION.
Tongji Univ., Shanghai (China). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5F.
W90-08790

AUTOMATED METHOD FOR PROCESSING CONSUMER DEMAND INFORMATION WITH REFERENCE TO WATER DISTRIBUTION SYSTEM MODELLING--THE DEVELOPMENT OF A DEMAND ALLOCATION AND MAPPING PACKAGE (DAMP).
Severn-Trent Water Authority (England).
For primary bibliographic entry see Field 5F.
W90-08791

PRACTICAL APPLICATION OF COMPUTER AIDED SIMULATION AND OPTIMIZATION TO THE LEICESTER WATER SUPPLY MELBOURNE AQUEDUCTS SYSTEM.
Severn-Trent Water Authority, Leicester (England). Eastern Div.
For primary bibliographic entry see Field 5F.
W90-08815

NATIONAL FOREST SYSTEM: AMERICA'S HEADWATERS.
Lolo National Forest, Missoula, MT.
A. E. Rosquist.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 1-7, 2 fig, 11 ref.

Descriptors: *Forest watersheds, *Headwaters, *Headwaters hydrology, *Water supply, *Watershed management, Forest Service, Institutions, River basin development, River basins, Water management.

National Forest System lands in the western United States comprise 21% of the region's total land area but yield over 55% of the region's streamflow and provide more than 90% of the West's usable water supply. Particularly in the west, more headwater basins are in public ownership and managed as National Forests. The great rivers of the west (the Columbia, Missouri, Colorado, Platte, and Rio Grande) all have their headwaters in National Forests. Twenty National Forests straddle the Continental Divide between Canada and Mexico and another two dozen lie along the slopes of the Cascade and Sierra Nevada Mountain Ranges. Outside the Forest Service, the agency charged with administering the National Forests, these facts seem lost to water and land management planners struggling to resolve the almost universally recognized 'coming water supply crisis.' Water resource planners must be aware of the value of these National Forest watersheds and take steps to become involved in the planning of their management and development. (See also W90-08822) (Author's abstract)
W90-08823

EQUITABLE GROUNDWATER MANAGEMENT IN THE TUCSON ACTIVE MANAGEMENT AREA.
Arizona Univ., Tucson. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 4B.
W90-08848

ECONOMIC ANALYSIS OF IRRIGATION SYSTEMS.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 3F.
W90-08954

HYDROPOWER RESEARCH AND DEVELOPMENT IN MINNESOTA.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.

R. E. A. Arndt, and J. S. Gulliver.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 125-133, Fall 1989. 9 fig, 25 ref.

Descriptors: *Cost analysis, *Hydroelectric plants, *Hydroelectric power, *Water resources development, *Water use, Economic aspects, Hydraulic machinery, Minnesota, Turbines.

Hydropower was initially developed in the 1880s and grew steadily through the large public works projects of the 1930s. Although the operation of small hydropower plants waned during the period from 1940-1980, escalating energy costs fueled an increase in research and development in the early 1980s. Though hydropower development in Minnesota accounts for a relatively small percentage of its total electricity production (2-3%), it has a very favorable impact on Minnesota's economy. Every dollar saved on fuel purchases outside of Minnesota is the equivalent, considering the average economic turnover of money in Minnesota, to spending three dollars within the State. In addition, an estimated 320 million dollars of possible new construction of economical hydropower installations would also represent a significant boost to the local economy since hydropower is a technology that can be developed with Minnesota-based engineering firms and construction contractors. The current hydropower capacity of Minnesota is 165 megawatts (MW), with additional potential capacity of 164 MW. Of this potential capacity, 72 MW is currently under development. Research is being conducted by the St. Anthony Falls Hydraulic Laboratory on water quality issues and improving the technology of hydropower plants. (Tappert-PTT)
W90-08989

CALCULATING COLLECTIVE IRRIGATION NETWORKS WITH DEMAND LIMITATIONS (CALCUL DES RESEAUX COLLECTIFS D'IRRIGATION AVEC LIMITATION DE LA DEMANDE).
J. M. Revuelta Prieto.
Houille Blanche HOBLAB, Vol. 1990, No. 1, p 73-77, 1990. 1 fig, 3 tab, 5 ref. English summary.

Descriptors: *Irrigation design, *Irrigation engineering, *Irrigation requirements, *Water demand, Clement method, Flow rates, Mathematical equations, Probability distribution, Statistical analysis, Water resources management.

The use of the Clement method for calculating the flow of an irrigation network with on-demand water distribution is briefly discussed. When water demand is limited by the incoming flow rate, the binomial distribution of probabilities (which justifies the Clement formula) must be replaced by a real distribution. However, if a reasonable probability (rather than absolute certainty) will suffice, then good results can be achieved by dimensioning the branches or the irrigation network for the simultaneous operation of a number of inlets. The method is illustrated by the case of an irrigation system with a total flow of 300 L/sec distributed through a network having 100 inlets, each with a capacity of 10 L/sec. Obviously the demand is limited when no more than 30 inlets are in simultaneous operation. The method has the following disadvantages: (1) it can lead to over-dimensioning of the irrigation network, especially in the branches far from the head; (2) as the head of the network is approached, operating efficiency is so very low that an invalidation of the formula would be justified; and (3) in order to improve the efficiency in the head of the network, the probability of each inlet being in operation is artificially decreased by increasing the hours used for irrigation. This makes the method even more artificial, by assigning the same probability of operation during the nighttime as during the day. (Creskoff-PTT)
W90-09059

CLIMATE INDUCED HYDROLOGICAL SHIFTS IN EUROPE AND THEIR IMPLICATION SPECTRUM--UNIQUE OPPORTUNITY TO STRENGTHEN HYDROLOGY.

Swedish Natural Science Research Council, Stockholm.
For primary bibliographic entry see Field 2B.
W90-09092

EFFECTS OF CLIMATE VARIATION OF PUBLIC WATER SUPPLY.
Central Forecast Office, Lusaka (Zambia). Dept. of Meteorology.
For primary bibliographic entry see Field 2B.
W90-09104

GLOBAL CLIMATIC CHANGE: IMPLICATIONS FOR ENERGY POLICY.
Minnesota Univ., Minneapolis. Hubert H. Humphrey Inst. of Public Affairs.
For primary bibliographic entry see Field 2A.
W90-09105

IMPACT OF CLIMATE ON THE OPERATION OF THE FRENCH ELECTRIC SYSTEM.
Electricite de France, Grenoble.
For primary bibliographic entry see Field 2B.
W90-09106

STUDY OF WATER RESOURCES SYSTEMS OPERATION TAKING ACCOUNT OF CLIMATIC CHANGES.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2A.
W90-09112

COMPARISON OF DISCHARGE METHODS AND HABITAT OPTIMIZATION FOR RECOMMENDING INSTREAM FLOWS TO PROTECT FISH HABITAT.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
For primary bibliographic entry see Field 8I.
W90-09250

6E. Water Law and Institutions

LIFE OF ITS OWN: THE POLITICS AND POWER OF WATER.
California Univ., Los Angeles.
For primary bibliographic entry see Field 6D.
W90-08747

RIVERS AT RISK: THE CONCERNED CITIZEN'S GUIDE TO HYDROPOWER.
American Rivers, Inc., Washington, DC.
J. Echeverria, P. Barrow, and R. Roos-Collins.
Island Press, Washington, DC. 1989. 214p.

Descriptors: *Ecological effects, *Environmental impact, *Federal Energy Regulatory Commission, *Hydroelectric power, *Water resources development, *Watershed management, Dams, Federal jurisdiction, Licensing, Multiobjective planning, Public participation, Public policy.

By early 1988, according to the Federal Energy Regulatory Commission (FERC), more than 2,000 hydro projects were operating. A project often consists of several dams, so the number of actual structures is even larger. The US EPA has estimated private hydro dams at 15,000. The large discrepancy in the figures suggests the lack of comprehensive oversight given to river development. FERC estimates that 1,500 new dams may eventually be built, continuing to extinguish natural rivers. This book is directed toward anyone trying to deal with hydro dams. The book aims to help the individual: (1) intervene in hydropower proceedings; (2) direct hydro development away from rivers deserving preservation; (3) deal efficiently with the Federal Energy Regulatory Commission; and (4) use hydro licensing and relicensing procedures to guarantee adequate fish passage, sufficient water releases, and better public access to rivers. The book deals with nonfederal hydro dams, which are under the jurisdiction of FERC, rather than with public dams, which are operated by

various federal agencies such as the Army Corps of Engineers and the Bureau of Reclamation. Nonfederal projects include those operated by utilities, independent power producers, manufacturers, cities and towns, and so on. These make up 90% of existing hydro projects. (Lantz-PTT)
W90-08748

PROTECTING NONTIDAL WETLANDS.
Maryland Dept. of Natural Resources, Annapolis. Nontidal Wetlands Div.
For primary bibliographic entry see Field 2H.
W90-08757

CHESAPEAKE EXECUTIVE COUNCIL, FIRST PROGRESS REPORT UNDER THE 1987 CHESAPEAKE BAY AGREEMENT.
Environmental Protection Agency, Annapolis, MD. Chesapeake Bay Program.
For primary bibliographic entry see Field 5G.
W90-08760

BRIEF HISTORY OF WILDERNESS WATER POLICY IN THE UNITED STATES.
Kansas State Univ., Manhattan. Dept. of Landscape Architecture.
A. R. Tautges.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 9-20, 1 tab, 40 ref.

Descriptors: *Environmental policy, *Forest watersheds, *Headwaters hydrology, *Legislation, *Wilderness areas, Federal jurisdiction, History, Legal aspects, Regulations.

The most significant watersheds in the United States have their origins within the boundaries of federally designated wilderness areas. A brief history of the federal policies which have affected water resources in wilderness is outlined. Though a legal definition of wilderness did not exist in the United States until The Wilderness Act of 1964, the origins of wilderness as a public land use data back to formation of the first 'Forest Reserves', 'Primitive Areas', and the Forest Service regulations of Robert Marshall. Other policies of importance to wilderness water issues include the Multiple-Use Sustained Yield Act, National Environmental Policy Act (1969), Federal Land Policy and Management Act (1976), National Forest Management Act (1976), and the Alaska National Interest Lands Conservation Act (1980). (See also W90-08822) (Author's abstract)
W90-08824

NONPOINT SOURCE POLLUTION MANAGEMENT AND COMPLIANCE WITH REGULATORY MANDATES.
Forest Service, San Francisco, CA. Range and Watershed Management.
For primary bibliographic entry see Field 5G.
W90-08825

FEDERAL NONPOINT SOURCE CONTROL EFFORTS--HISTORICAL GAO OBSERVATIONS.
General Accounting Office, Washington, DC.
For primary bibliographic entry see Field 5G.
W90-08826

INSTITUTIONAL BARRIERS TO POLICY CHANGE--IMPLICATIONS FOR RIPARIAN HABITAT PROTECTION IN ARIZONA.
Arizona Univ., Tucson. School of Renewable Natural Resources.
M. E. Wilkosz, and D. A. King.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 259-267, 32 ref.

Descriptors: *Arizona, *Environmental protection, *Headwaters hydrology, *Institutional constraints, *Public policy, *Riparian rights, Administrative decisions, Political aspects, Riparian land, Riparian waters, Social aspects.

The degradation and destruction of riparian habitats in Arizona has been an issue of public concern since the late 1960's. Scientific, environmental, and recreational interest groups have attempted to pressure government into creating policies fostering riparian habitat protection and management. In the past decade pressure has increased considerably. One reason why policy change has not yet occurred is that there are several formidable institutional barriers to be overcome. Arizona currently lacks an effective decision-making forum that could help to overcome these barriers. This paper describes why riparian areas are important to Arizona, and discusses the administrative, political, cultural, and ideological barriers to policy change. One possible organizational solution to these barriers would be a new forum for public, multiple-group, and interagency participation. Such a forum could provide the opportunity for administrative coordination and group consensus-building so that coordinated and politically acceptable policy changes could be achieved. (See also W90-08822) (Author's abstract)
W90-08849

WATER ALLOCATION UNDER A RIPARIAN SYSTEM TAKING INTO ACCOUNT SURFACE AND GROUNDWATER INTERACTIONS--THE CASE OF IRRIGATION DEVELOPMENT IN THE HEADWATERS OF THE SUSQUEHANNA RIVER.
Cornell Univ., Ithaca, NY.
T. S. Steenhuis, and D. Allee.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 341-350, 3 fig, 12 ref.

Descriptors: *Headwaters hydrology, *Riparian land, *Riparian waters, *Susquehanna River, *Water allocation, *Water rights, *Water supply, Flow discharge, Hydrologic regime, Irrigation water, Low flow, Model studies, Surface-groundwater relations.

The Susquehanna River Basin Commission has adopted a rule that any withdrawal that would reduce the flow below a 'seven day, ten year' quantity must be made up by reservoir releases or terminated. This is to assure flows sufficient for instream uses and discharges to the Chesapeake Bay. Irrigation can both withdraw water from current flows and enlarge flows at a future time due to the augmentation of groundwater. Timing may be such that the augmented groundwater reaches the stream at or near the natural low flows. Thus, irrigation may serve a function in flow management similar to reservoir releases. New storage for low flow releases is expected to be expensive and controversial. Modeling of irrigation development and the surface/groundwater system to meet these institutional needs involved some unique procedures. Organizational arrangements to limit withdrawals in the driest years would be difficult to develop and enforce unless there were careful development of understanding of the need for such constraints and defensible accuracy in their application. This modeling has provided the planning and management tools required to plan at the basin level yet regulate at the individual farm level. (See also W90-08822) (Author's abstract)
W90-08857

COMPREHENSIVE COUNTY WATER PLANNING PROCESS IN SOUTH CENTRAL MINNESOTA.
Mankato State Univ., MN. Dept. of Biological Sciences.
For primary bibliographic entry see Field 6B.
W90-08993

INTERBASIN WATER TRANSFERS: AN ECONOMIC PANACEA OR A POLITICAL PLOY.
For primary bibliographic entry see Field 6C.
W90-08994

Group 6E—Water Law and Institutions

LEGISLATIVE COMMISSION ON MINNESOTA RESOURCES INVOLVEMENT IN WATER RESOURCE PROGRAMS.
J. Velin, and G. Orning.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 158-160, Fall 1989.

Descriptors: *Grants, *Minnesota, *Water resources institutes, *Water resources management, Legal aspects, Zoning.

The Legislative Commission on Minnesota Resources (LCMR) has funded more than $32 million worth of projects in three water-related areas since 1963. These areas include water resource description and use, improved techniques for water management, and projects that contribute to the development and preservation of water resources. The Commission has funded inventory programs which better define and describe the location, quality, and amount of use for both surface and groundwater resources. Representative studies include an inventory of the state's lakeshore resources, programs to map and computerize rivers and drainage ditches, and a variety of groundwater contamination studies. The Commission has also sponsored programs to foster the development of comprehensive water policy and program management guidelines, including zoning studies and local water planning legislation. In three water resource-related areas (lakes, wetlands, and rivers), the Commission has invested money for both resource acquisition and development. (Tappert-PTT)
W90-08995

PERSPECTIVE ON BIOLOGICAL ASSESSMENTS.
Monsanto Co., St. Louis, MO.
For primary bibliographic entry see Field 5G.
W90-09003

GROUND WATER: A STATE GOVERNMENT PERSPECTIVE.
For primary bibliographic entry see Field 5G.
W90-09086

TOXIC SUBSTANCES IN SURFACE WATER.
George Washington Univ., Washington, DC. Div. of Occupational and Environmental Medicine.
For primary bibliographic entry see Field 5G.
W90-09214

TRANSMISSION MAIN ANSWERS WATER WOES.
R and D Engineering and Land Surveying, Buffalo, NY.
For primary bibliographic entry see Field 5F.
W90-09230

RATIONALE FOR OHIO'S DETERGENT PHOSPHORUS BAN.
International Joint Commission-United States and Canada, Windsor (Ontario). Great Lakes Regional Office.
For primary bibliographic entry see Field 5G.
W90-09343

ACID RAIN POLICY IN THE NETHERLANDS: APPLICATION OF MEDIATION TECHNIQUES.
Institute for Environment and Systems Analysis, Amsterdam (Netherlands).
For primary bibliographic entry see Field 5C.
W90-09359

USE OF AN ECOSYSTEM APPROACH TO RESTORE DEGRADED AREAS OF THE GREAT LAKES.
Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Fisheries Research Branch.
For primary bibliographic entry see Field 5G.
W90-09360

RECENT DEVELOPMENTS IN ENVIRONMENTAL PROTECTION IN INDIA: POLLUTION CONTROL.

For primary bibliographic entry see Field 5G.
W90-09361

WATER RIGHTS LAWS IN THE NINETEEN WESTERN STATES. VOLUME III.
W. A. Hutchins.
Miscellaneous Publication No. 126, United States Department of Agriculture, Washington, D.C. 1977. 793p.

Descriptors: *Water rights, *Water law, *Legal aspects, *International law, International waters, *Interstate compacts, Interstate rivers, International agreements, Water use, Interagency cooperation, Water policy.

Federal-State relations, interstate dimensions of water rights, and international law affecting water rights are reviewed. Subjects covered include: commerce power, federal power, legislative proposals, litigation between states, validity of state legislative restrictions on interstate water use, and international water treaties between the United State, Canada, and Mexico. In an appendix, the water-rights systems in operation in the nineteen western states are summarized. A table of cases cited is also included. (See W76-02105, W76-03916 and W90-09308 thru W90-09310) (White-Reimer-PTT)
W90-09371

FEDERAL-STATE RELATIONS.
H. H. Ellis, and J. P. De Braal.
IN: Water Rights Laws in the Nineteen Western States. Volume III, Miscellaneous Publication No. 1206, United States Department of Agriculture, Washington, D.C. 1977. p 1-65.

Descriptors: *Administrative agencies, *Interagency cooperation, *Jurisdiction, Legislation, Water rights, *Water law, *Legal aspects, Navigable waters, Interstate commerce, Federal waters, State waters.

The national framework of Federal Constitutional and statutory provisions and related court decisions, particularly as they affect the operation of the water laws of the Western States are examined. Insofar as consistent with Federal, interstate, or international limitations, each State may adopt its own system of water law; however, States are only quasi-sovereign. Economic activity and movement within the United States require that State powers be limited in the interests of interstate commerce. Judicial or statuatory criteria by which to determine navigable waters for various Federal purposes may vary, depending on the particular constitutional or statutory provisions or matters at issue. The Supreme Court has recognized the States' vital interest in the control over navigable water for the interests of their citizens until congress in some way asserts its superior power. In some cases the land involved may be owned as part of the public domain or may have been acquired for the performance of various governmental functions. In these cases questions may arise concerning the use of water originating on or flowing through the land. The respective roles of Federal and State Governments in regard to water rights have been a subject of controversy for a number of years. Various bills pertaining to this matter were introduced in the Congress subsequent to the Pelton Dam case in 1955, but none were acted upon through 1974. While it is apparent that the Federal powers relating to water resources are quite extensive, in practice Congress has provided for or enabled various methods of recognizing State water-rights laws and has provided for consultation and participation by the States in several Federal projects. (See also W90-09307) (White-Reimer-PTT)
W90-09372

INTERSTATE DIMENSIONS OF WATER RIGHTS.
H. H. Ellis, and J. P. DeBraal.
IN: Water Rights Laws in the Nineteen Western States. Volume III, Miscellaneous Publication No. 1206, United States Department of Agriculture, Washington, D.C. 1977. p 66-115.

Descriptors: *Water rights, Judicial decisions, *Appropriation, *Water law, *Legal aspects, *Interstate compacts, *Interstate rivers, Colorado, Utah, Water use.

The United States Supreme Court is the forum for the judicial settlement of disputes between States over the apportionment of the waters of interstate streams and bodies of water. The law evolving from interstate controversies acts as a limit upon the internal water law of the States. A summary of the results of interstate water controversies is presented. Interstate compacts may have various effects upon private rights and State legislation relating to water. An interstate compact may operate as a restriction upon private rights held under State law that are inconsistent with the compact and in some cases may be held to be unconstitutional. Interstate compacts may adversely affect private or public water rights previously established by State law. Several statutes have been enacted in the Western States regarding the question of the appropriation of water in one State for use in another State. Some of the variations in such legislation include: (1) Colorado legislation which provides that it is unlawful to divert or transport the waters of streams or other sources of water in the State for use into any other State for use therein; and (2) Utah legislation which provides that water may be appropriated from interstate streams in Utah, to be conveyed into any border State for use therein, provided the sister State has reciprocal legislation. (See also W90-09307) (White-Reimer-PTT)
W90-09373

INTERNATIONAL LAW AFFECTING WATER RIGHTS.
Catholic Univ. of America, Washington, DC.
G. G. Waite.
IN: Water Rights Laws in the Nineteen Western States. Volume III, Miscellaneous Publication No. 1206, United States Department of Agriculture, Washington, D.C. 1977. p 116-140.

Descriptors: *Water law, *Legal aspects, *International agreements, *International law, Mexico, Canada, United States, *Water rights, Water use.

Disputes over the use of resources common to more than one nation are resolved by application of international law, which, in addition to treaties, includes generally accepted principles limiting national sovereignty. These principles are called 'customary international law' and guide the International Court of Justice, or other international tribunals, in pronouncing judgement. The substance of customary international law may be inferred from similar provisions in a number of treaties. Treaties of the United States with Canada and Mexico have not explicitly pre-empted private rights created by the various States adjoining the two frontiers. However, by apportioning the waters of international and transboundary streams, and by establishing classes of preferred water uses, the treaties do limit the States' ability to create water rights. Only uses fitting within the national share of water, and within the hierarchy of uses may be effectively established by the States. Any State-based right to use water is susceptible to obliteration should it conflict with future treaty provisions. Whether the private owners of such rights are compensated for their loss depends on the terms of the treaty, or separate congressional action--there is no constitutional requirement that they be paid. To the extent the international agencies refine the treaty-established preferences in water use, the possibility exists for planning the water uses of an entire river basin, without regard to State or national boundaries. (See also W90-09307) (White-Reimer-PTT)
W90-09374

ENVIRONMENTAL MONITORING PROGRAMS OF THE U.S. FISH AND WILDLIFE SERVICE.
Fish and Wildlife Service, Washington, DC. Div. of Environmental Contaminants.
For primary bibliographic entry see Field 5A.
W90-09464

LIABILITY RULES FOR GROUNDWATER PESTICIDE CONTAMINATION.
Georgia Univ., Athens. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 5G.
W90-09477

6F. Nonstructural Alternatives

WATER MARKETING EFFECTS ON CROP-WATER MANAGEMENT.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 3F.
W90-08934

6G. Ecologic Impact Of Water Development

GAS-BUBBLE DISEASE IN THREE FISH SPECIES INHABITING THE HEATED DISCHARGE OF A STEAM-ELECTRIC STATION USING HYPOLIMNETIC COOLING WATER.
Duke Power Co., Huntersville, NC. Applied Science Center.
For primary bibliographic entry see Field 5C.
W90-08686

TRANSLOCATION OF AN ESTUARINE WHELK AND ITS TREMATODE PARASITES IN AUSTRALIA.
Scripps Institution of Oceanography, La Jolla, CA.
For primary bibliographic entry see Field 4C.
W90-08729

DOWN BY THE RIVER: THE IMPACT OF FEDERAL WATER PROJECTS AND POLICIES ON BIOLOGICAL DIVERSITY.
C. E. Hunt, and V. Huser.
Island Press, Washington, DC. 1988. 260p.

Descriptors: *Colorado River, *Columbia River, *Ecological effects, *Environmental effects, *Mississippi River, *Missouri River, *Public policy, *Riparian land, *River basins, *Snake River, *Water resources development, *Wildlife habitats, Diversion, History, Hydroelectric plants, Locks, Navigation canals, Reservoirs, Riparian vegetation, Riparian waters, Water storage.

Riparian habitats are among the world's richest ecosystems, their distinctive and rapidly disappearing vegetation feeds an equally distinctive array of wildlife, which has an economic and aesthetic value that cannot be outweighed by the construction of another housing project, a new federally financed dam, more unsupervised livestock grazing, or the further channelization of a river. Yet all of these activities have destroyed or harmed riparian habitats, despite the fact that their values for controlling soil erosion, stream siltation and flooding, and for recreation can be quantified in dollars and cents. This book describes the impacts of federal water projects and policies on riparian habitats. Various river basins are used as examples of specific types of impacts, and to illustrate weaknesses in the water resources planning system. In most of the basins discussed, the rivers have been developed for multiple purposes. In order to more clearly underline the individual project and policy functions, however, one water or related land use is emphasized in each chapter. The Columbia River dams, for example, provide water to croplands and contain navigation locks, but Chapter 3 describes the effects of the huge hydroelectric systems along the Columbia and Snake Rivers. The Colorado River dams are also multipurpose, but Chapters 4 and 5 dwell on their storage and diversion of water for irrigation. All of the environmental impacts attributed to hydroelectric facilities on the Columbia, also occur on the Colorado, the Missouri, and other rivers with large dams and hydropower facilities. Similarly, the impacts produced by storage of water for agriculture along the Colorado also occur to some extent on the Columbia and Missouri rivers. Each chapter contains some description of the natural history of the river

basin or basins being discussed. Most chapters also contain some of the human history that has influenced the economic use of the region: Chapter 7--'Huck Finn's Habitat, the Upper Mississippi'; Chapter 8--'The Lower Mississippi Valley, Southern Swamps and Soybeans'; and Chapter 9--'Southeastern Shipping Lanes'. (Lantz-PTT)
W90-08746

RIVERS AT RISK: THE CONCERNED CITIZEN'S GUIDE TO HYDROPOWER.
American Rivers, Inc., Washington, DC.
For primary bibliographic entry see Field 6E.
W90-08748

KANAWHA RIVER BASIN WATER QUALITY MODELING.
Hydrologic Engineering Center, Davis, CA.
For primary bibliographic entry see Field 5G.
W90-08764

ARCTIC GRAYLING COEXIST WITH DAM SAFETY IMPROVEMENTS.
HKM Associates, Billings, MT.
For primary bibliographic entry see Field 8I.
W90-08831

CUMULATIVE EFFECTS OF HUMAN ACTIVITIES ON BULL TROUT (SALVELINUS CONFLUENTUS) IN THE UPPER FLATHEAD DRAINAGE, MONTANA.
Montana Dept. of Fish, Wildlife and Parks, Kalispell.
For primary bibliographic entry see Field 4C.
W90-08834

OPPORTUNITIES FOR RIPARIAN ECOSYSTEM PRESERVATION IN THE VERDE RIVER BASIN, ARIZONA.
Environmental Defense Fund, Oakland, CA.
For primary bibliographic entry see Field 5G.
W90-08858

WATER SEEPAGE FROM UNLINED DITCHES AND RESERVOIRS.
Cornell Univ., Ithaca, NY.
For primary bibliographic entry see Field 4A.
W90-08933

PROTECTING THE WET COMMONS.
Scripps Institution of Oceanography, La Jolla, CA.
E. D. Goldberg.
Environmental Science and Technology ESTHAG, Vol. 24, No. 4, p 450-454, April 1990. 2 fig, 3 tab, 19 ref.

Descriptors: *Aquaculture, *Policy making, *Water quality control, Disasters, Economic aspects, Ecosystems, Fish farming, Fish ranching, Legal aspects, Management planning, Regulations.

Throughout the world there are continuing dramatic increases in the farming and ranching of aquatic organisms. On a global basis, aquaculture constituted about 10% of the fish landings in 1985 (about 10.5 million tons). There are two classes of mariculture: ranching and farming, distinguished on the basis of whether the organisms are fed by the operator (farming) or feed on natural prey and then are captured when mature (ranching). Mariculture can compete for wet commons space with recreation activities and with waste disposal. In addition, it can degrade the environment, jeopardize the integrity of ecosystems, and compete for food and habitat with natural populations. Antibiotics and pesticides are used to prevent crop failures in fish farming, yet little is known about the consequences of these agents for the non-target species. Mariculture can be affected by the entry of domestic and industrial wastes into the cultivation areas. Other uses of the ocean that are placing increasing demands on the wet commons are waste accommodation, recreation, and transportation. The identification of extensive mariculture will require the development of marine property rights. Government control is needed to deal with such

problems as accidental or deliberate harvesting of ranched salmon. More effective use of the open ocean commons for the disposal and perhaps storage, of noncyclable wastes, including hazardous wastes, probably will occur. Economic and social pressures will lead to more effective use of marine areas that can be determined by scientists and engineers to accommodate waste. Management of unexpected, rare events, such as the Exxon Valdez oil spill, should be in the hands of scientists and engineers rather than bureaucrats. (Rochester-PTT)
W90-08940

EFFECT OF SADDAM DAM ON TIGRIS RIVER WATER QUALITY.
For primary bibliographic entry see Field 5B.
W90-08962

ENVIRONMENTAL IMPACT ON CLIMATE DUE TO MANMADE RESERVOIRS.
Centro di Ricerca Idraulica e Strutturale, Milan (Italy).
For primary bibliographic entry see Field 2A.
W90-09107

DESTRUCTION OF SPAWNING GROUNDS OF MAHSEER AND OTHER FISH IN GARHWAL HIMALAYAS.
Garhwal Univ., Srinagar (India). Dept. of Zoology.
For primary bibliographic entry see Field 4C.
W90-09194

EFFECTS OF IMPOUNDMENT ON THE PHYSICOCHEMISTRY OF TWO CONTRASTING SOUTHERN AFRICAN RIVER SYSTEMS.
Rhodes Univ., Grahamstown (South Africa). Inst. of Freshwater Studies.
J. H. O'Keefe, R. W. Palmer, B. A. Byren, and B. R. Davies.
Regulated Rivers Research & Management RRRMEP, Vol. 5, No. 2, p 97-110, March/May 1990. 6 fig, 3 tab, 29 ref.

Descriptors: *Dam effects, *Limnology, *Physicochemical properties, *Reservoirs, *River flow, *Rivers, *South Africa, *Water chemistry, *Water quality, Chemical properties, Nutrients, Serial Discontinuity Concept, Water temperature.

The downstream effects of six impoundments on their respective physicochemical conditions between April 1986 and September 1987 were compared to two contrasting South African rivers. The impoundments studied included two on a cool, clear, clean, acid, and short system with a steep gradient (Palmiet River), and four on a warm, turbid, polluted, alkaline, and relatively long system (Buffalo River). Where possible, results were also compared against prediction of the Serial Discontinuity Concept of Ward and Stanform, and the recovery (discontinuity) distances were estimated for a number of variables. The Serial Discontinuity Concept describes expected disruptions and subsequent recovery in rivers downstream of impoundments. Major effects centered on changes in median spot temperatures and annual temperature ranges, particularly for dams regulating the upper reaches of both rivers. These upper river impoundments behaved similarly despite different release patterns, and caused only weak chemical effects, most of which recovered rapidly (within 3 km). Middle reach impoundments also behaved similarly despite different release characteristics, but they caused more pronounced changes and recovery distance were longer (up to 30 km). Observed exceptions to the predictions of the Serial Discontinuity Concept included alterations to nutrient regimes of receiving reaches downstream of all dams, annual temperature range was affected downstream of headwater dams on both rivers, and all impoundments on both systems depressed flow fluctuations. Although the specific predictions of the Serial Discontinuity Concept model was not generally borne out, it was regarded as a useful tool for testing the effects of impoundment on rivers, and the concept of recovery distance

forms a useful practical framework for management of releases. (Mertz-PTT)
W90-09248

ELEMENT TRANSPORT IN REGULATED AND NON-REGULATED RIVERS IN NORTHERN SWEDEN.
Umea Univ. (Sweden). Dept. of Physical Geography.
For primary bibliographic entry see Field 2E.
W90-09253

MANAGEMENT OF THE SAI RIVER AND THE TATSUMI CANAL, JAPAN.
Kanazawa Inst. of Tech. (Japan). Dept. of Mechanical System Engineering.
T. Nakagawa, and S. I. Miyae.
Regulated Rivers Research & Management RRRMEP, Vol. 5, No. 2, p 183-188, March/May 1990. 4 fig, 1 tab, 10 ref.

Descriptors: *Canals, *Dam effects, *Dams, *Environmental preservation, *Japan, *Tatsumi canal, Check dams, Conservation, Environmental protection, Flood control, History, Hydroelectric power, Water quality, Water storage.

The Tatsumi canal, Japan, constructed by Hyoshiro Itaya in 1632, is of immeasurable cultural value. The canal is about 10 km long. It was used to provide water for fire-fighting in towns surrounding Kanazasa Castle, to maintain water-level in the moats, and to provide drinking water for the people of the castle. In 1982, Ishikawa Prefecture, Japan proposed the construction of a multipurpose dam on the Sai River for flood control, hydroelectric power generation, and water storage. This plan conflicts with the preservation of cultural properties as well as the environment: part of the ancient Tatsumi canal will be destroyed and the ecological system, which includes several rare species, around the dam site will be disturbed. An alternative measure that fulfills the purposes of the dam construction and preservation of the Tatsumi canal is presented. The alternative measure consists of widening the channel of the Sai River for flood control, and modification of the existing Heraso checkdam so as to fulfill the requirements of hydroelectric power generation and water storage. The proposed alternative also allows the preservation of the natural environment around the dam site and maintenance of water quality in the Tatsumi canal. (Mertz-PTT)
W90-09255

TEMPORAL AND SPATIAL VARIATIONS IN IRON CONCENTRATIONS OF TROPICAL BIVALVES DURING A DREDGING EVENT.
Newcastle upon Tyne Univ. (England). Dept. of Biology.
For primary bibliographic entry see Field 2L.
W90-09296

7. RESOURCES DATA

7A. Network Design

WATER AND EFFLUENT MANAGEMENT IN INDUSTRY: OBTAINING AND USING INFORMATION TO FACILITATE MEANINGFUL DECISION MAKING.
Council for Scientific and Industrial Research, Pretoria (South Africa).
For primary bibliographic entry see Field 5G.
W90-08772

DESIGN, PLACEMENT, AND SAMPLING OF GROUNDWATER MONITORING WELLS FOR THE MANAGEMENT OF HAZARDOUS WASTE DISPOSAL FACILITIES.
Argonne National Lab., IL. Energy and Environmental Systems Div.
For primary bibliographic entry see Field 5G.
W90-08773

SUBSURFACE SCIENCE PROGRAM: DEEP MICROBIOLOGY TRANSITIONAL PROGRAM IMPLEMENTATION PLAN.
Department of Energy, Washington, DC. Div. of Ecological Research.
For primary bibliographic entry see Field 5G.
W90-08775

COMPARISON OF THE GRADIENT METHOD WITH SOME TRADITIONAL METHODS FOR THE ANALYSIS OF WATER SUPPLY DISTRIBUTION NETWORKS.
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W90-08779

LONDON'S WATER SUPPLY IN THE 21ST CENTURY--COMPUTER MODELLING ASPECTS.
Thames Water Authority, Reading (England). Planning Dept.
For primary bibliographic entry see Field 5F.
W90-08784

APPLICATIONS OF MICROCOMPUTERS IN THE DESIGN AND OPTIMISATION OF WATER SUPPLY AND DISTRIBUTION SYSTEMS IN DEVELOPING COUNTRIES.
City Univ., London (England). Thermo-Fluids Engineering Research Center.
For primary bibliographic entry see Field 5F.
W90-08787

FAULT ANALYSIS AND FLUID TRANSIENT SUPPRESSION IN PIPELINES AND NETWORKS.
City Univ., London (England). Thermo-Fluids Engineering Research Center.
For primary bibliographic entry see Field 5F.
W90-08795

SIMULATION OF TRANSIENT PHENOMENA IN INTERNAL FLOW SYSTEMS.
Warwick Univ., Coventry (England). Dept. of Engineering.
For primary bibliographic entry see Field 5F.
W90-08796

TRANSIENT HYDRAULIC ANALYSIS OF CONDUIT SYSTEMS IN MULTI-REGIME CONDITIONS.
Atkins (W.S.) International, Epsom (England).
For primary bibliographic entry see Field 5F.
W90-08797

TELEMETRY SYSTEM DESIGN AND ON-LINE DECISION SUPPORT WITH 'TCLAS' SOFTWARE.
Trent Polytechnic, Nottingham (England).
A. Bargiela, and G. D. Hainsworth.
IN: Computer Applications in Water Supply. Volume 2: Systems Optimization and Control. John Wiley and Sons, Inc., New York, New York. 1988. p 1-11. 4 fig, 6 ref.

Descriptors: *Computer models, *Computer programs, *Data processing, *Pipe flow, *Telemetry, *Water metering, *Water pressure, Computer analysis, Computers, DATACON, Model studies, Telemetry confidence limit analysis, Water conveyance, Water demand.

TCLAS (telemetry confidence limit analysis) is an interactive program to be used in decision support and as a tool for designing the best meter configuration for a telemetry system. The program calculates error bounds on all network flows and pressures under given metering conditions. The user interface is geared towards ease of modifying metering configurations and analyzing numerical values of error bounds together with their potential errors. TCLAS can be used in both static and dynamic modes. The two most important features of TCLAS are its graphical display and its interactive input. Much of the information is presented as

an overlay to a schematic diagram of the network or after the interactive cursor has been moved to a particular point of the network and data requested. In order to facilitate a user friendly environment for the creation of a network description data file used by TCLAS a sister program, DATACON, has been developed. This is an interactive graphical program for the creation and amendment of general water network data files and has a separate option for the creation of TCLAS data files. The whole software suite is highly portable, has been written entirely in FORTRAN 77, and has been successfully run on both UNIX and VMS operating systems. (See also W90-08799) (Mertz-PTT)
W90-08800

SIMPLIFICATION OF WATER SUPPLY DISTRIBUTION SYSTEMS FOR OPTIMAL OPERATIONS.
Tongji Univ., Shanghai (China). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5F.
W90-08810

OPTIMIZATION OF URBAN WATER DISTRIBUTION SYSTEMS.
Tongji Univ., Shanghai (China). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5F.
W90-08813

FOUR-LEVEL HIERARCHY FOR ORGANIZING WILDLAND STREAM RESOURCE INFORMATION.
Forest Service, Milwaukee, WI.
For primary bibliographic entry see Field 2E.
W90-08827

VARIABILITY OF SOIL WATER TENSION IN A TRICKLE IRRIGATED CHILE PEPPER FIELD.
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
For primary bibliographic entry see Field 3F.
W90-08952

MODEL OF COMBINED WATER USE AND WATER DERIVATION PLANNING.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 6A.
W90-09029

SPECIFIC FEATURES OF WATER DYNAMICS IN DIFFERENT TYPES OF LAKES.
Akademiya Nauk SSSR, Petrozavodsk. Karelskii Filial.
For primary bibliographic entry see Field 2H.
W90-09033

TWO APPROACHES TO DESIGN OF MONITORING NETWORKS.
Geological Survey, Boise, ID.
T. B. Spruill, and L. Candela.
Ground Water GRWAAP, Vol. 28, No. 3, p 430-442, May/June 1990. 10 fig, 3 tab, 20 ref.

Descriptors: *Data acquisition, *Groundwater quality, *Monitoring, *Network design, *Water quality, Aquifers, Chlorides, Error analysis, Hydrologic data collections, Kriging, Sampling, Spain, Spatial distribution, Statistical methods, Test wells.

Two different approaches to the design of a groundwater quality monitoring network may be appropriate, depending on the type of information desired. First, where the objective is to determine what groundwater quality characteristics are like in an area, networks can be designed to provide estimates of known reliability using standard parametric assessments where the intention of the monitoring network is to provide data about general suitability of the water for various uses. Second,

where the objective is to maximize areal groundwater quality information, networks also can be designed using geostatistical techniques, such as kriging. Both approaches were applied to 1965 chloride data from a deep confined aquifer in the Llobregat delta near Barcelona, Spain. Traditional statistical techniques are used to design a network to provide an estimated median chloride concentration. On the basis of 120 observations in the 1965 data set, between 13 and 25 wells would be necessary to estimate the median chloride concentration within 40% of the true median with 95% confidence. Kriging was applied to the data set to determine the minimum number of wells necessary to include in the network to retain the essential spatial information of the original network. By use of this technique, the original network of 120 wells was reduced by 17.5% to 99 wells, while the standard error was increased by only 1%. A comparison of these two approaches indicates that a network designed using geostatistical techniques generally will require larger sample sizes than networks designed by traditional techniques, but the geostatistical techniques can provide data adequate to describe both stochastic and spatial features of water quality variables. Detailed description of spatial variability requires many sample points for extremely variable data. On the basis of the present results, prediction errors for chloride concentrations in groundwater at selected points in the Llobregat delta were as much as 300%. Nevertheless, even the modified network of 99 wells would produce statistical estimates adequate for most general water quality assessments, in addition to retaining the spatial information contained in the original 1965 data set. (Author's abstract)
W90-09143

ENVIRONMENTAL SAMPLING: A SUMMARY.
Radian Corp., Austin, TX.
For primary bibliographic entry see Field 5A.
W90-09215

WMO SOLID PRECIPITATION MEASUREMENT INTERCOMPARISON: OBJECTIVES, METHODOLOGY, ANALYSIS.
Atmospheric Environment Service, Downsview (Ontario).
B. E. Goodison, B. Sevruk, and S. Klemm.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 57-64, 2 fig, 3 tab, 15 ref.

Descriptors: *Data acquisition, *Network design, *Rain, *Snow density, *Snow gages, Fences, Precision, Wind, World Meteorological Organization.

The World Meteorological Organization has initiated an international intercomparison to assess national methods of measuring solid precipitation to determine wind related errors and to derive standard methods of correcting solid precipitation measurements. An experimental design has been developed for countries to use at their evaluation sites. After reviewing all possible methods for the snowfall Intercomparison (bush shield, double fence shield, forest clearing, snow board measurement, dual-gage approach) the organizing committee designated the octagonal vertical double fence shield as the Intercomparison Reference (DFIR). The fences are inscribed into circles 12 m and 4 m in diameter, with the outer fence 3.5 m high and inner fence 3 m high surround a Tretyakov precipitation gage mounted at a height of 3 m. The outer and inner fences have gaps of 2 m and 1.5 m, respectively, between them and the ground. A review of correction procedures, based largely on the relationship between wind speed and gage catch, provides the methodology for subsequent analyses. Preliminary results from different countries confirm that gage catch generally decreases with increasing wind speed, with unshielded gages measuring significantly less (e.g. 24% of reference at 6 m/sec wind) than their shielded counterparts. (See also W90-09408) (Lantz-PTT)
W90-09415

INFORMATION CONTENT EVALUATION FOR ACID DEPOSITION NETWORK REMEDIATION.
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
J. R. Donald, and E. A. McBean.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 137-144, 5 fig, 1 tab, 10 ref.

Descriptors: *Acid rain, *Air pollution, *Data acquisition, *Monitoring, *Network design, *Ontario, *Path of pollutants, *Sulfates, Air pollution trends, Decision making, Kriging, Spatial distribution.

The need to estimate the amount and pattern of air pollutants has resulted in the establishment of acid precipitation monitoring networks throughout north-eastern North America. A methodology has been developed by which existing precipitation chemistry monitoring networks can be examined to determine the impact of station removal on the ability of a network to reflect the true deposition field. The methodology was applied to annual sulfate deposition estimation for the region of southern Ontario, and was carried out using the following steps: (1) estimate the spatial distribution of the sulfate deposition field; (2) identify optimal station removal locations; (3) develop information content measures; and (4) utilize the information content measures to generate information loss curves for network evaluation. The global spatial representation of deposition amounts over southern Ontario does not seem to be affected by the removal of stations from the network. This is shown by the maximum 7% of observed change in the total deposition level with removal of 50% of the stations within the region, over the available period of record. These results indicate that many stations may be removed from the Acid Precipitation in Ontario Study Cumulative Wet Deposition Network (APIOS-C) network without any appreciable loss in the estimation of total deposition. However, one must be very selective in the removal of stations is important. Other network criteria, such as the detection of temporal trends in deposition, require continuous data sets over long durations in order to detect trends with confidence. The removal of stations with an established record length could be detrimental to the evaluation of temporal deposition trends. The mean kriging variance, root mean square error, and error in total deposition techniques can be used to evaluate the impact of station removal on the information content of a region. If criteria other than regional quantification are involved, such as the maintenance cost or data quality of specific stations, the effect of station removal alternatives can be evaluated and utilized in the decision process. (See also W90-09408) (Lantz-PTT)
W90-09424

ASSESSMENT OF OCCURRENCE OF AGRICULTURAL CHEMICALS IN RURAL, PRIVATE WATER SUPPLIES.
Illinois State Water Survey Div., Champaign.
S. C. Schock, E. Mehnert, D. P. McKenna, and S. C. Mravik.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 90-100, 2 fig, 12 ref.

Descriptors: *Agricultural chemicals, *Data acquisition, *Groundwater pollution, *Illinois, *Monitoring, *Pollutant identification, *Water quality, Drinking water, Network design, Public health, Surveys, Water supply.

The Illinois State Water Survey and Illinois State Geological Survey have developed a plan to assess the occurrence of agricultural chemicals in rural, private drinking water wells. Elements of the plan include precise definitions of the sampled population and statistical sampling method. The sampling population would be all rural, drilled, private water supply wells in Illinois. The sampling design

would be stratified random sampling from wells of different potential for contamination, based on the depth to the uppermost aquifer materials. These samples would be analyzed for the easily leached agricultural chemicals most used in Illinois. The chosen sampling design allows statistically valid inferences to be drawn regarding the occurrence of these agricultural chemicals in the entire population of wells by sampling selected subpopulations. The sampling plan is structured so that temporal differences in the occurrence of agricultural chemicals in wells from within the strata may be statistically verifiable. A site survey or reconnaissance form and a comprehensive questionnaire for interviewing the owner/user of each well has also been developed. The information gathered from the survey form and questionnaire and the chemical analytical results for each well would be computerized, allowing results to be restratified for analysis by other variables. A pilot study has been funded. A state wide study is dependent on evaluation of pilot study results. (See also W90-09440) (Author's abstract)
W90-09447

ORGANIZATION AND OPERATION OF THE SAVANNAH RIVER PLANT'S GROUNDWATER MONITORING PROGRAM.
Du Pont de Nemours (E.I.) and Co., Pompton Lakes, NJ.
For primary bibliographic entry see Field 5A.
W90-09506

7B. Data Acquisition

ANALYSIS OF SIX FORAGING BEHAVIORS AS TOXICITY INDICATORS, USING JUVENILE SMALLMOUTH BASS EXPOSED TO LOW ENVIRONMENTAL PH.
State Univ. of New York at Syracuse. Coll. of Environmental Science and Forestry.
For primary bibliographic entry see Field 5A.
W90-08654

HIGH PERFORMANCE LIQUID CHROMATOGRAPHIC SEPARATION OF FISH BILIARY POLYNUCLEAR AROMATIC HYDROCARBON METABOLITES.
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 5A.
W90-08655

MONITORING OF PERSISTENT, LIPOPHILIC POLLUTANTS IN WATER AND SEDIMENT BY SOLVENT-FILLED DIALYSIS MEMBRANES.
Lund Univ. (Sweden). Dept. of Ecology.
For primary bibliographic entry see Field 5A.
W90-08667

THERMALLY DRIVEN CIRCULATION WITHIN AN EXPERIMENTAL ENCLOSURE.
Sveriges Meteorologiska och Hydrologiska Inst., Goeteborg. Oceanografiska Lab.
L. Andersson, and L. Rahm.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 2, p 111-129, February 1990. 10 fig, 1 tab, 15 ref.

Descriptors: *Mathematical models, *Water circulation, *Water temperature, Baltic Sea, Coastal waters, Eddy diffusivity, Model studies, Vertical circulation.

A diagnostic advection-diffusion model for the temperature field in an experimental enclosure is presented. The enclosed fluid domain is divided into a buoyancy layer at the nonhorizontal walls, and an horizontally homogenous, stably stratified interior. Given thermal forcing through the top surface and the side walls, together with the interior temperature profile, the interior vertical velocity field, as well as the eddy diffusivity at the boundary layer, are estimated for an advection-dominated case. This model has been applied to a pilot experiment, a limnocorral study in the coastal region of the Baltic Sea. The thermally driven

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interior vertical circulation, forced by the buoyancy layer, is found in the range 0-0.01 m/s, while the characteristic eddy diffusivity at the buoyancy layer typically varies between 0.1 to 10 sq micrometers/s. Hence, the distribution of biologically interesting parameters, as well as their sources and sinks, may be estimated using a similar advection-diffusion model for the substance in question, but where the velocity field and eddy diffusivity is calculated, by use of the present model. (Author's abstract)
W90-08734

FIELD MEASUREMENTS OF SEDIMENT TRANSPORT PARAMETERS IN ESTUARIES.
Birmingham Univ. (England). Dept. of Civil Engineering.
J. R. West, O. K. Oduyemi, A. J. Bale, and A. W. Morris.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 2, p 167-183, February 1990. 11 fig, 2 tab, 19 ref.

Descriptors: *Estuarine environment, *Instrumentation, *Measuring instruments, *Sediment transport, Fall velocity, Mathematical equations, Particulates, Sediment properties, Shear stress, Suspension density, Turbulence.

Field measurements have been made in the upper reaches of a partially mixed estuary to develop a system of measurements that would provide insight into the parameters associated with the transport of the cohesive and granular sediment mixtures found in the turbidity maximum reaches of estuaries. Measurements were made with electromagnetic current meters, siltmeters, an Owen tube and an in situ particle size analyzer. The data were analyzed to determine relationships between particulate concentrations, fall velocity, suspension density, turbulent mean velocity and bed shear stress. These techniques are capable of producing useful results for the investigation of estuarine sediment transport processes and formulae. The shear stress can be determined accurately and particle size and fall velocity can be determined to a suitable level of accuracy for a useful range of field conditions. Several areas to improve field accuracy were outlined: turbulent velocity measurements made at several points over the whole water column; vertical profile measurements of turbulent mean velocity, salinity, and suspended solids made at more frequent intervals and a more appropriate transport formulae developed for cases where acceleration and longitudinal density gradients effects are influential; the Owen tube evaluated for sampling mixtures of granular and flocculating suspensions, and more measurements during a tidal cycle made; in situ analysis improved by quantifying the particle size fitting obscuration corrections, changing the cell path lengths, and making more frequent observations during the tidal cycle. In general the application of the above techniques at several sites together with a careful analysis of the bed sediments should result in a considerable improvement in the knowledge of estuarine sediment transport processes and formulae. (Brunone-PTT)
W90-08736

CLOUD SEEDING, DATA COLLECTION AND ANALYSIS ASSOCIATED WITH THE COLORADO RIVER AUGMENTATION DEMONSTRATION PROGRAM, 1985-86 SEASON.
North American Weather Consultants, Salt Lake City, UT.
For primary bibliographic entry see Field 3B.
W90-08754

REPORT OF THE SCIENCE STEERING GROUP FOR A TROPICAL RAINFALL MEASURING MISSION (TRMM).
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
Available from the National Technical Information Service, Springfield, VA. 22161, as N89-19789. Price codes: A06 in paper copy, A01 in microfiche. August 1988. 94p, 57 fig, 28 tab, 30 ref.

Descriptors: *Data acquisition, *Instrumentation, *Meteorology, *Rainfall, *Remote sensing, *Satel-

lite technology, *Tropical Rainfall Measuring Mission, Rain gages, Rainfall rate, Tropical storms.

The Tropical Rainfall Measuring Mission (TRMM) is a satellite program being studied jointly by the United States and Japan, which would carry out the systematic study of tropical rainfall required for major strides in weather and climate research. The first two chapters of this report are devoted to the scientific background and the deficiencies in current knowledge which lead to the need for TRMM. Chapter III states the science requirements, in terms of priority science questions, related important science and remote sensing questions, and the accuracy and resolution requirements. Chapter IV poses the overall approach to be adopted, addressing the question of whether tropical rainfall can be adequately sampled by a low Earth orbiter with the planned instrument swaths. Chapter V describes the instrument complement, spacecraft, and the proposed system concept, including command, data relay, and tracking. Chapter VI is a summary of the relevant work on rain retrieval methods and their testing, which has advanced substantially during 1988. Chapter VII outlines the validation or 'ground truth' program involving combinations of remote and in situ measurements from the surface supplemented by special experiments with instrumented aircraft. Finally, Chapter VIII describes the structure of an end-to-end data flow scheme for TRMM including key elements of the science data processing approach. (Lantz-PTT)
W90-08763

SUBSURFACE SCIENCE PROGRAM: DEEP MICROBIOLOGY TRANSITIONAL PROGRAM IMPLEMENTATION PLAN.
Department of Energy, Washington, DC. Div. of Ecological Research.
For primary bibliographic entry see Field 5G.
W90-08775

COMPUTER APPLICATIONS IN WATER SUPPLY. VOLUME 1: SYSTEMS ANALYSIS AND SIMULATION.
For primary bibliographic entry see Field 5F.
W90-08776

NETWORK ANALYSIS--THE REAL STORY.
WRc Engineering, Swindon (England).
For primary bibliographic entry see Field 5F.
W90-08780

SOME DYNAMIC DEMAND ASPECTS OF NETWORK ANALYSIS MODELLING.
Ward, Ashcroft and Parkman, Chester (England).
For primary bibliographic entry see Field 5F.
W90-08781

USE OF SIMULATION MODELS OF WATER SUPPLY SYSTEMS--PROCESSING OF INPUT AND OUTPUT DATA.
Laboratorio Nacional de Engenharia Civil, Lisbon (Portugal).
For primary bibliographic entry see Field 5F.
W90-08786

USE OF THERMODYNAMIC PUMP TESTING IN CONJUNCTION WITH WATER DISTRIBUTION NETWORK MODELS.
Severn-Trent Water Authority, Birmingham (England). Western Div.
For primary bibliographic entry see Field 5F.
W90-08794

TRANSIENT HYDRAULIC ANALYSIS OF CONDUIT SYSTEMS IN MULTI-REGIME CONDITIONS.
Atkins (W.S.) International, Epsom (England).
For primary bibliographic entry see Field 5F.
W90-08797

THEORETICAL FOUNDATION AND EMPIRICAL FRAMEWORK FOR EVALUATING IN-

TERBASIN WATER TRANSFER POLICY: THE CASE OF SOUTH CAROLINA WATER SYSTEM.
Clemson Univ., SC.
J. C. O. Nyankori.
IN: Computer Applications in Water Supply. Volume 1: Systems Analysis and Simulation. John Wiley and Sons, Inc., New York, New York. 1988. p 430-441. 1 fig, 4 tab, 9 ref.

Descriptors: *Computer models, *Cost-benefit analysis, *Interbasin transfers, *South Carolina, *Water allocation, *Water conveyance, *Water policy, *Water transport, Computer analysis, Computer programs, Computers, Model studies, Nash equilibria, Pricing, Tomlins linear complementarity problem, Water demand, Water supply, Water use.

The consumption and pricing consequences of interbasin water transfer are examined within the theoretical constructs of spatial competition. Specifically, the development of a centralized statewide water system in South Carolina that permits interbasin water transfer was researched. An empirical model, in accordance with the Nash equilibria conditions and estimated using Tomlin's linear complementarity problem, was used. The results showed optimal residential water demand and supply quantities together with the associated prices, and indicate that there were benefits, in a welfare sense, from interbasin water transfers. The results have important implications for policy making. The South Carolinian example indicated that in sub-basin 1 (the deficit area), there would be more water available at lower rates to consumers with interbasin water transfer, and supply systems in sub-basin 1 would operate slightly under full capacity. In sub-basin 2 (the surplus area), consumers would face slightly higher prices and consequently, demand less water with interbasin water transfers. Finally, supply systems in sub-basin 2 would operated more closely to full capacity with interbasin water transfers. The model is computationally efficient and yields generally acceptable results that are consistent with theoretical predictions. The program was written in FORTRAN and was run on NAS AS/XL-60. (See also W90-08776) (Mertz-PTT)
W90-08798

TELEMETRY SYSTEM DESIGN AND ON-LINE DECISION SUPPORT WITH 'TCLAS' SOFTWARE.
Trent Polytechnic, Nottingham (England).
For primary bibliographic entry see Field 7A.
W90-08800

TELEMETRY SYSTEM CONTROL: THE RTK KERNEL--A GENERAL SOLUTION.
Information Processing Ltd., Bath (England).
For primary bibliographic entry see Field 5F.
W90-08801

PUMP SCHEDULING IN WATER SUPPLY: MORE THAN A MATHEMATICAL PROBLEM.
WRc Engineering, Swindon (England).
For primary bibliographic entry see Field 5F.
W90-08814

FOUR-LEVEL HIERARCHY FOR ORGANIZING WILDLAND STREAM RESOURCE INFORMATION.
Forest Service, Milwaukee, WI.
For primary bibliographic entry see Field 2E.
W90-08827

TRACING STORMFLOW SOURCES IN SEEPAGE ZONES USING OXYGEN-18.
Pennsylvania State Univ., University Park. School of Forest Resources.
For primary bibliographic entry see Field 2A.
W90-08873

DEFINING HYDROLOGIC CHARACTERISTICS OF HEADWATERS FORESTED WATER-

SHEDS IN THE SOUTHERN INTERIOR OF BRITISH COLUMBIA.
British Columbia Ministry of Forests, Kamloops.
For primary bibliographic entry see Field 2A.
W90-08880

USE OF A HYDRAULIC POTENTIOMANO-METER TO DETERMINE GROUND-WATER GRADIENTS IN A WETLAND, COLORADO.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2F.
W90-08890

CONSTRUCTION AND CALIBRATION OF A RAINFALL SIMULATOR.
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).
For primary bibliographic entry see Field 2B.
W90-08903

EVAPOTRANSPIRATION FROM AN OAK FOREST INFESTED BY MISTLETOE.
Universitaet fuer Bodenkultur, Vienna (Austria). Inst. fuer Meteorologie, Klimatologie und Grundlagen der Physik.
For primary bibliographic entry see Field 2D.
W90-08921

EVALUATING PLANT WATER STRESS WITH CANOPY TEMPERATURE DIFFERENCES.
National Oceanic and Atmospheric Administration, Idaho Falls, ID. Environmental Research Labs.
For primary bibliographic entry see Field 3F.
W90-08929

HIGH-INTENSITY RAINFALL RATE DETERMINATION FROM TIPPING-BUCKET RAIN GAUGE DATA.
Agricultural Research Service, Florence, SC. Coastal Plains Soil and Water Conservation Research Center.
For primary bibliographic entry see Field 2B.
W90-08931

GROWTH AND NITROGEN ECONOMY OF RICE UNDER SPRINKLER AND FLOOD IRRIGATION IN SOUTH EAST AUSTRALIA: III. 15N BALANCE.
Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Centre for Irrigation Research.
For primary bibliographic entry see Field 3F.
W90-09019

ERRORS IN THE ESTIMATION OF PRE-EX-CISION PLANT WATER POTENTIAL.
Agricultural Research Service, Tucson, AZ.
For primary bibliographic entry see Field 2I.
W90-09023

SNOW COVER AND SNOWMELT RUNOFF MODEL IN THE FOREST ZONE.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2C.
W90-09028

EXPERIMENTAL-ANALYTICAL METHOD OF MODELLING TRANSFORMATION OF NATURAL ORGANIC MATTER IN WATER STORAGE RESERVOIRS.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2H.
W90-09030

SEAWATER INTRUSION INTO ESTUARIES AND AQUIFERS.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2L.
W90-09031

EXAMINATION OF MODEL ADEQUACY AND ANALYSIS OF PHOSPHORUS DYNAMICS IN LAKE KUORTANEENJARVI: A CASE STUDY WITH TWO LAKE MODELS.
Helsinki Univ. of Technology, Espoo (Finland). Lab. of Hydrology and Water Resources Engineering.
For primary bibliographic entry see Field 5B.
W90-09032

ANALYSIS OF HOLLOW FIBER BIOREAC-TOR WASTEWATER TREATMENT.
Cincinnati Univ., OH. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W90-09034

LABORATORY SIMULATION OF DIFFUSION IN CONTAMINATED MARINE SEDIMENTS.
Louisiana State Univ., Baton Rouge. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5B.
W90-09046

STUDY OF INORGANIC LIGAND-CHROMIUM(III)-SURFACE TERNARY COMPLEXES BY ESR SPECTROSCOPY.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland). Inst. of Aquatic Sciences.
For primary bibliographic entry see Field 2K.
W90-09053

RADON-222 IN DRINKING WATER: AN NJDEP-EERF COLLABORATIVE STUDY.
New Jersey Dept. of Environmental Protection, Trenton. Div. of Environmental Quality.
For primary bibliographic entry see Field 5A.
W90-09055

COPRECIPITATION OF TRACE METALS BY DNA AND RNA MOLECULES.
Hiroshima Univ. (Japan). Faculty of Integrated Arts and Sciences.
For primary bibliographic entry see Field 5A.
W90-09113

RAIN ESTIMATION FROM INFRARED AND VISIBLE GOES SATELLITE DATA.
Washington Univ., Seattle. Dept. of Statistics.
For primary bibliographic entry see Field 2B.
W90-09123

METHOD FOR THE EXTRACTION OF CAR-BONACEOUS PARTICLES FROM LAKE SEDIMENT.
University Coll., London (England). Palaeoecology Research Unit.
For primary bibliographic entry see Field 5A.
W90-09126

INVESTIGATION BY DC RESISTIVITY METHODS OF A GROUND-WATER BARRIER BENEATH THE SAN BERNARDINO VALLEY, SOUTHERN CALIFORNIA.
California Univ., Riverside. Inst. of Geophysics and Planetary Physics.
For primary bibliographic entry see Field 2F.
W90-09133

ESTIMATION OF LEAK RATES FROM UN-DERGROUND STORAGE TANKS.
ENSR, Acton, MA.
For primary bibliographic entry see Field 5B.
W90-09138

ROLE OF PUMPING TESTS IN SITE CHAR-ACTERIZATION: SOME THEORETICAL CONSIDERATIONS.
Kansas State Geological Survey, Lawrence.
For primary bibliographic entry see Field 2F.
W90-09140

GROUND-WATER CONTAMINATION BY HIGH-DENSITY IMMISCIBLE HYDROCAR-BON SLUGS IN GRAVITY-DRIVEN GRAVEL AQUIFERS.
Washington State Univ., Pullman. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5B.
W90-09141

NATURAL VARIABILITY IN PHOTOSYN-THETIC ENERGY CONVERSION EFFICIEN-CY: A FIELD STUDY IN THE GULF OF MAINE.
Brookhaven National Lab., Upton, NY. Oceanographic Sciences Div.
For primary bibliographic entry see Field 2L.
W90-09145

EMPIRICAL EQUATIONS RELATING SCALAR IRRADIANCE TO A, B/A, AND SOLAR ZENITH ANGLE.
Rochester Univ., NY. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-09149

MAPPING SATURATED AREAS WITH A HEL-ICOPTER-BORNE C BAND SCATTERO-METER.
Centre de Recherches en Physique de l'Environnement, Issy-les-Moulineaux (France).
C. Brun, R. Bernard, D. Vidal-Madjar, C. Gascuel-Odoux, and P. Merot.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 945-955, May 1990. 12 fig, 2 tab, 34 ref.

Descriptors: *Data acquisition, *Mapping, *Rainfall-runoff relationships, *Remote sensing, *Runoff, *Saturated soils, *Soil water, Agricultural watersheds, Aircraft, Helicopters, Microwaves, Radar, Scatterometer, Storm runoff, Vegetation, Watersheds.

A helicopter-borne C band scatterometer was used to locate the saturated areas within a small watershed in France. Calibration showed a backscatter coefficient decreasing for the high gravimetric water contents of the saturated areas, possibly due to the increasing importance of specular reflection processes. With optimal configuration for soil moisture campaigns (15 deg incidence angle, HH polarizations) a -5-dB threshold of radar backscattering cross section was determined. This roughly corresponded to a mean surface soil gravimetric moisture higher than 45%. For actual field conditions, results were slightly better when a radar signal treatment was performed in order to get a signal on a homogeneous field without any effects from houses or hedges. Another configuration of radar, corresponding to an ERS 1 satellite simulation, was tested. In these conditions a -7-dB threshold gave good agreement with saturated areas. (Cassar-PTT)
W90-09168

COMPARISONS OF THREE DIFFERENT EN-RICHMENT TECHNIQUES IN THE DETER-MINATION OF LEAD IN TAP WATER AND BOTTLED WATER BY FLAME ATOMIC AB-SORPTION SPECTROMETRY.
Technical Univ. of Istanbul (Turkey). Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W90-09201

ENVIRONMENTAL SAMPLING: A SUMMA-RY.
Radian Corp., Austin, TX.
For primary bibliographic entry see Field 5A.
W90-09215

COLLOIDAL BEHAVIOR OF ACTINIDES IN AN OLIGOTROPHIC LAKE.
Argonne National Lab., IL. Environmental Research Div.
For primary bibliographic entry see Field 5B.
W90-09219

Group 7B—Data Acquisition

HEAVY SNOWFALL WITHIN A MESOSCALE CONVERGENCE ZONE.
Meteorological Office, High Wycombe (England).
For primary bibliographic entry see Field 2C.
W90-09227

PLANT PIGMENTS AS TRACERS OF EMERGENT AND SUBMERGENT MACROPHYTES FROM THE HUDSON RIVER.
New York Botanical Garden, Bronx, NY. Inst. of Ecosystem Studies.
T. S. Bianchi, and S. Findlay.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 3, p 492-494, 1990. 1 fig, 2 tab, 18 ref. Hudson River Foundation grant 003/88A/077.

Descriptors: *Aquatic vegetation, *Carotenoids, *Chlorophyll, *Hudson River, *Macrophytes, *Pigments, *Tracers, Chlorophyll b, Lutein, Myriophyllum, Pickerelweeds, Plants, Pondweeds, Scirpus, Trapa, Typha, Water celery, Waterlilies.

Ratios of photosynthetic pigment concentrations in aquatic macrophytes can provide a useful way to differentiate between inputs of emergent versus submergent macrophytes into aquatic food webs. Using reversed-phase high-performance liquid chromatography the distribution of carotenoid and chlorophyll pigment markers in eight macrophytes from the tidal freshwater portion of the Hudson River were examined. Emergent macrophytes included Typha angustifolia, Nuphar advena, Pontederia cordata, Trapa natans, and Scirpus fluviatilis; submergent forms were Vallisneria americana, Potamogenton sp., and Myriophyllum sp. Lutein was the most abundant carotenoid in all macrophytes, and concentrations in the emergent forms were significantly higher. Chlorophyll-b showed significantly higher concentrations in the submerged macrophytes than in the emergent forms. The chlorophyll-b/lutein ratio may be a useful marker to distinguish between organic inputs of submergent and emergent forms of macrophytes in aquatic ecosystems. (Mertz-PTT)
W90-09234

SAMPLER FOR INTERSTITIAL FAUNA IN ALLUVIAL RIVERS.
Centre National de la Recherche Scientifique, Toulouse (France). Centre d'Ecologie des Ressources Renouvelables.
E. Tabacchi.
Regulated Rivers Research & Management RRRMEP, Vol. 5, No. 2, p 177-182, March/May 1990. 1 fig, 2 tab, 25 ref.

Descriptors: *Aquatic animals, *Biological samples, *Bottom sampling, *Hynes sampler, *Rivers, *Samplers, *Sampling, *Trap efficiency, France, Plankton, Trapping, Water level fluctuations.

Interstitial fauna play an important role in the colonization processes of natural or regulated fluvial systems. Sampling of the interstitial fauna in river banks is often impeded by substrate heterogeneities and by variations of water level. An improved Hynes' sampler is designed to study the mesofauna and microfauna inhabiting higher levels of fluvial alluvium affected by frequent water level fluctuations. The one-meter-long sampler is formed by three concentric cylinders made of polyvinyl chloride pipes. The surface of each pipe is abraded to facilitate the colonization and adhesion by organisms. The external cylinder is perforated with 20 mm holes. This external cylinder is implanted within the substrate and left permanently throughout the period of survey. The middle cylinder is perforated with 13 mm holes in 100 mm wide bands alternating with nonperforated bands. The inner cylinder is perforated so that its holes can be matched with those of the middle cylinder when both pipes are interlocked. The trap itself is filled with the substratum extracted during the implantation of the external pipe. Twenty traps were set up on the littoral zone of a gravelly pond influenced by the fluctuations of the water table in the valley of the River Adour, southwest France. Most traps were submerged in February and therefore exclusively terrestrial groups are absent after this period. The results show: a low selectivity towards planktonic species; the same rate of capture for eggs, larvae, subadults, and adults; and a possibility of understanding the variability within the alluvium between the different compartments studied. Low selectivity, sampling of a volume, time and space replication without disturbing the surrounding substrate, and samples that are representative of the variability of the substrata are all advantages of using the new devise. (Mertz-PTT)
W90-09254

PHOTODISSOCIATION/GAS DIFFUSION/ION CHROMATOGRAPHY SYSTEM FOR DETERMINATION OF TOTAL AND LABILE CYANIDE IN WATERS.
Dionex Corp., Sunnyvale, CA.
For primary bibliographic entry see Field 5A.
W90-09263

STRONTIUM ISOTOPE STUDIES OF ATMOSPHERIC INPUTS TO FORESTED WATERSHEDS IN NEW MEXICO.
New Mexico Univ., Albuquerque. Dept. of Biology.
For primary bibliographic entry see Field 2K.
W90-09265

UTILISATION OF LIQUID CHROMATOGRAPHY IN AQUATIC PHOTODEGRADATION STUDIES OF PESTICIDES: A COMPARISON BETWEEN DISTILLED WATER AND SEAWATER.
Instituto de Quimica Bio-Organica, Barcelona (Spain). Dept. of Environmental Chemistry.
For primary bibliographic entry see Field 5A.
W90-09269

USE OF CLADOPHORA GLOMERATA TO MONITOR HEAVY METALS IN RIVERS.
Durham Univ. (England). Dept. of Biological Sciences.
B. A. Whitton, I. G. Burrows, and M. G. Kelly.
Journal of Applied Phycology JAPPEL, Vol. 1, No. 4, p 293-299, December 1989. 1 fig, 5 tab, 20 ref.

Descriptors: *Algae, *Analytical methods, *Bioaccumulation, *Bioindicators, *Cladophora, *Heavy metals, *Rivers, *Water analysis, Cadmium, Copper, England, Iron, Lead, Regression analysis, Synergistic effects, Zinc.

Methods were developed for the use of Cladophora glomerata to monitor heavy metal concentrations in flowing waters. At least under conditions without marked fluctuations in ambient metal concentration, there was no detectable difference in the metal concentrations of young plants between terminal 2 cm lengths of filament and whole plants. In order to establish the relationship between metal concentration in plant and that in water, 60 algal and water samples were analyzed from sites in northern England for Fe, Cu, Zn, Cd, and Pb. Other environmental variables were measured at the time in order to assess their influences on metal accumulation. There were highly significant correlations for each of the five metals between concentrations in alga and water. The regression equations relating metal in alga to metal in water permit an unknown environmental metal concentration to be estimated from the algal metal concentration. Multiple stepwise regression analyses were used to indicate environmental factors which may influence metal accumulation; for instance, Fe appeared to have a positive influence on Cu accumulation. In general, Cladophora accumulated much less metal than bryophytes did, but the slope relating metal in alga to metal in water was steeper, particularly for Pb. This means that Cladophora is especially useful where there is a need for a sensitive indicator of differences between sites or sampling occasions. (Author's abstract)
W90-09275

MICROPHYTOBENTHIC PIGMENTS IN A SALT MARSH POND DETERMINED BY HPLC AND SPECTROPHOTOMETRY.
IFREMER, Paris (France).
R. G. Barlow, Y. Collos, S. Y. Maestrini, and S. Roy.
Marine Microbial Food Webs, Vol. 4, No. 1, p 117-128, 1990. 6 fig, 1 tab, 25 ref.

Descriptors: *Algae, *Analytical techniques, *Benthic flora, *Biomass, *Chlorophyll a, *Chromatography, *Limnology, *Salt marshes, *Sediment analysis, *Wetlands, High performance liquid chromatography, Microorganisms, Phytoplankton, Pigments, Ponds.

The widespread use of chlorophyll a as a measure of microphytobenthic biomass means that reliable extraction procedures and analytical techniques must be adopted for the accurate determination of pigments. An assessment was made of two extraction procedures and two analytical techniques for determining chlorophyll a as a measure of microphytobenthic pigments. It was concluded that an extraction procedure using acetone should involve at least three extraction steps plus homogenization to extract all the pigments from sediment samples. There is generally good agreement between spectrophotometric and high performance liquid chromatography techniques for determining chlorophyll a. However, since there are inherent problems associated with the acid correction in the spectrophotometric assay, the isocratic high performance liquid chromatography method seems to provide a good compromise between chromatographic simplicity, speed and accuracy. The use of shorter 10 cm chromatographic columns packed with 3 micrometer particles could shorten retention times considerably. An accurate estimate of the phaeopigments present in sediments can only be obtained using gradient high performance liquid chromatography or thin-layer chromatographic techniques. A detailed analysis of pigments in sediment cores revealed that pigments were concentrated in the upper cm and that reliable estimates of phaeopigments can only be obtained by chromatographic quantitation. (Mertz-PTT)
W90-09294

TROPICAL PRECIPITATION RATES DURING SOP-1, FGGE, ESTIMATED FROM HEAT AND MOISTURE BUDGETS.
Purdue Univ., Lafayette, IN. Dept. of Earth and Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W90-09305

MESOSCALE ORGANIZATION OF SPRINGTIME RAINSTORMS IN OKLAHOMA.
Washington Univ., Seattle. Dept. of Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W90-09306

SUPPLEMENTARY METHOD FOR ASSESSING THE RELIABILITY OF FLUIDS SAMPLED FROM DEEP AQUIFERS.
Hebrew Univ. of Jerusalem (Israel). Seagram Centre for Soil and Water Sciences.
R. Nativ.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 2, p 83-88, Spring 1990. 2 fig, 1 tab, 11 ref.

Descriptors: *Aquifers, *Deep wells, *Drilling fluids, *Sample preservation, *Sampling, *Test wells, *Water analysis, *Water sampling, Boreholes, Chemical properties, Drill-stem test, Israel, Salinity, Sample contamination, Swab test, Temperature.

Sampling of formation water from deep aquifers for salinity and temperature measurements involves problems not often encountered when sampling groundwater from shallow aquifers during a pumping test. In deep aquifers, sampling of formation fluid to determine salinity is done during a drill-stem test (DST) or a swab test. Samples obtained by a DST or swab test often do not represent formation fluids because of contaminants that affect the chemical composition of the fluids. The problem of formation of fluid contamination by drilling fluids or cushion water can be overcome

by adding a tracer to all drilling fluids. Temperature measurements in deep formations are generally done by lowering a thermometer into the borehole and correlating the recorded temperature to the total depth attained at the time. More than 800 temperature measurements using a maximum borehole thermometer and more than 100 measurements on formation fluid sampled during a DST were taken (during the drilling and testing) from 215 wildcat boreholes that penetrate the deep aquifers (3300 to 16,400 feet) of Israel. Wherever the temperature of the recovered fluid is lower than the temperature measured in the drilling mud at the same interval, the fluid is likely to be contaminated by mud, mud filtrate, or cushion water. Thus, when checking chemical analyses of historical samples or when evaluating the representativeness of a recently sampled fluid, potential contamination resulting from dilution with mud, mud filtrate, or cushion water also can be estimated using temperature data. (White-Reimer-PTT)
W90-09310

DEVELOPMENT OF A STANDARD, PURE-COMPOUND BASE GASOLINE MIXTURE FOR USE AS A REFERENCE IN FIELD AND LABORATORY EXPERIMENTS.
Arizona State Univ., Tempe. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5A.
W90-09315

AUTOMATED PERMEATION SAMPLER FOR PHENOLIC POLLUTANTS.
Akron Univ., OH. Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W90-09325

GENERALIZED LOW-FLOW FREQUENCY RELATIONSHIPS FOR UNGAGED SITES IN MASSACHUSETTS.
Tufts Univ., Medford, MA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-09348

CYCLES, FLUXES AND SPECIATION OF TRACE METALS IN THE ENVIRONMENT.
Essex Univ., Colchester (England). Inst. of Aerosol Science.
For primary bibliographic entry see Field 5B.
W90-09382

METAL SPECIATION IN SLUDGES FROM WASTEWATERS TREATMENT BY BULK AND SURFACE (XPS) ANALYSIS.
Basilicata Univ., Potenza (Italy). Inst. of Chemistry.
For primary bibliographic entry see Field 5D.
W90-09384

CHEMICAL EQUILIBRIUM ANALYSIS OF LEAD AND BERYLLIUM SPECIATION IN HAZARDOUS WASTE INCINERATORS.
Kansas State Univ., Manhattan.
A. P. Mathews.
IN: Metals Speciation, Separation, and Recovery. Volume II. Proceedings of the Second International Symposium on Metals Speciation, Separation, and Recovery, Rome, Italy, May 14-19, 1989. Lewis Publishers, Inc., Chelsea, Michigan. p 73-84, 4 fig, 17 ref.

Descriptors: *Beryllium, *Chemical analysis, *Chemical speciation, *Equilibrium, *Hazardous wastes, *Incineration, *Lead, *Pollutant identification, *Urban hydrology, *Wastewater disposal, Heavy metals, Inorganic compounds, Metals, Volatilization.

The increased use of incineration as a method of hazardous waste disposal can result in increased levels of toxic metals in the atmosphere. The quantity and nature of metal emissions will depend on the type of metal species formed in the combustion zone, and the efficiency with which the volatilized species are removed by the air pollution control

equipment. Chemical equilibrium analysis was used to predict the formation and concentration of beryllium and lead species under different operating conditions. Beryllium speciates into solid beryllium oxide at the lower temperature. At high temperatures and high excess air ratios beryllium is volatilized as beryllium dihydroxide. The presence of chlorine in the waste will not significantly affect beryllium speciation. Lead is volatilized readily as the halogenated species at the lower combustion temperatures, and as lead oxide and lead vapor at higher combustion temperatures, and as lead oxide and lead vapor at higher temperatures. Further studies must be undertaken to determine the condensation mechanisms for the various species, and the type and size distribution of particles formed, to facilitate the efficient capture and removal of these metals from the gas phase. (See also W90-09381) (Lantz-PTT)
W90-09385

PRECIPITATION DATA COMPATIBILITY IN NORTH AMERICA AND THE IMPACT ON STUDIES OF ACID DEPOSITION.
Canadian Climate Centre, Downsview (Ontario).
B. E. Goodison, and R. J. Vet.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 47-55, 1 fig, 3 tab, 14 ref.

Descriptors: *Acid rain, *Canals, *Data acquisition, *Error analysis, *Network design, *Performance evaluation, *Precipitation measurements, *Rain gages, *United States, Canadian Air and Precipitation Monitoring, National Atmospheric Deposition Program, Path of pollutants, Precision.

Errors in measured precipitation depth translate directly into errors in true wet deposition. The issues of absolute accuracy and data compatibility between networks are discussed. Known systematic errors in rain and snow precipitation depth measurements for Canadian and US methods used in the acid deposition networks are summarized. Differences between US and Canadian standard gauge measurements could be up to 30% for a mean wind speed of < 2 m/sec. An intercomparison of network methods of measurement for Canadian (Canadian Air and Precipitation Monitoring Network (CAPMoN)) and US (National Atmospheric Deposition Program/National Trends Network (NADP/NTN)) air quality networks showed that CAPMoN weekly precipitation depths were statistically significantly higher than NADP/NTN depths, with a between network bias of 1-2 mm/week. Analysis of seasonal and annual biases showed that the CAPMoN measurements were up to 22% higher in the winter season. Compatibility may be achieved by using common measurement methods or correcting precipitation measurements for systematic errors. (See also W90-09408) (Author's abstract)
W90-09414

WIND FIELD DEFORMATION ABOVE PRECIPITATION GAUGE ORIFICES.
Eidgenoessische Technische Hochschule, Zurich (Switzerland).
B. Sevruk, J. A. Hertig, and R. Spiess.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 65-70, 3 fig, 1 tab, 2 ref.

Descriptors: *Measuring instruments, *Rain gages, *Wind, Data acquisition, Performance evaluation, Precipitation, Wind velocity.

Seven types of precipitation gages having various sizes and forms of orifice rims were investigated in a wind tunnel. The wind speed and intensity of turbulence profiles above the gage orifice confirmed that the orifice rim considerably affects the wind field deformation. The gages with a large orifice rim or a bird protection ring showed the greatest increment of wind speed above the center

of the orifice. The smaller the gage orifice area, the greater was this effect. The intensity of turbulence was greater for gages with a small orifice rim and a large orifice area. (See also W90-09408) (Author's abstract)
W90-09416

MONITORING ATMOSPHERIC DEPOSITION IN CALIFORNIA'S SIERRA NEVADA: A COMPARISON OF METHODS.
Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.
B. J. McGurk, N. H. Berg, D. Marks, J. M. Melack, and F. Setaro.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 71-79, 3 fig, 1 tab, 12 ref. California Air Resources Board Grant A6-078-32.

Descriptors: *Acid rain, *California, *Forest watersheds, *Measuring instruments, *Pollutant identification, *Rain, *Sampling, *Snow gages, Alpine regions, Chemical analysis, Hydrogen, Mammoth Lake, Nevada, Nitrates, Sierra Nevada, Snow density, Sulfates.

Four methods for measuring atmospheric deposition in the Sierra Nevada of California were compared during the winter of 1986-1987. A large (28 by 122-cm) polyvinyl chloride tube was compared to a Belfort precipitation gage and to snowboards at both an exposed site, near Mammoth Lakes, and a site in a forest clearing, near Soda Springs. An Aerochem Metrics collector was also included at the forest site. At the exposed site, the tube and the Belfort gage caught 23% less snow water equivalent than the snowboards. In the clearing, the tube and the Belfort gage caught 17% more than the snowboards. Except for NO3 at the forest site, chemical analyses of samples from the tube and the snowboard showed that H, NO3, and SO4 concentrations differed significantly (p < 0.05). Laboratory tests showed no adsorption or desorption of synthetic standard solutions of major ions from the tube. For sheltered sites with occasional midwinter rain, the tube is recommended. For windy sites without midwinter rain, sampling from weekly snowboards provides a better estimate of chemical and snow volume loading. (See also W90-09408) (Author's abstract)
W90-09417

NEW JERSEY PESTICIDE USE SURVEY.
New Jersey Dept. of Environmental Protection, Trenton. Office of Science and Research.
For primary bibliographic entry see Field 5B.
W90-09455

METHODOLOGY FOR LOCATING AND MEASURING SUBMERGED DISCHARGES: TARGETING TOOL, HARPOON PIEZOMETER AND MORE.
Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
D. R. Lee, and S. J. Welch.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 1-8, 1 fig, 8 ref.

Descriptors: *Data acquisition, *Geohydrology, *Groundwater movement, *Instrumentation, *Piezometers, *Surface-groundwater relationships, Estuaries, Flow discharge, Leachates, Path of pollutants, Soil moisture meters, Stratigraphy.

One field problem in hydrology is locating and quantifying major zones of actual or potential contaminant input. Because surface waters are often on the receiving ends of groundwater flow systems, and because questions are now being raised regarding pollution of surface water by contaminated groundwater, this topic is getting increased attention. Techniques for collecting information to determine where and at what rate groundwater

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upwells in bodies of surface water have been developed, and have been used successfully for estimating landfill leachate entry in a river and for locating areas of fresh groundwater entry in the beds of estuaries. The approach involves: the towing of sediment probes over large areas in order to target small areas for detailed investigation; the driving of piezometers from boats or floating platforms for measurement of relative heads and collection of porewaters; the use of a piston corer, also from a boat, for mapping sediment stratigraphy and porewater chemistry; and the SCUBA usage of seepage meters for direct measure of specific discharge. The probe is towed in contact with the bottom sediment and gives a continuous record of bulk electrical conductance and temperature. A variety of field examples tell of the successes and failures of this methodology for measuring groundwater and contaminant flux to the surface. (See also W90-09479) (Author's abstract)
W90-09480

METHOD OF VERTICAL CONCENTRATION PROFILING IN AQUIFERS CONTAMINATED BY DNAPL.
C-E Environmental, Inc., Portland, ME.
For primary bibliographic entry see Field 5B.
W90-09481

COMPARISON OF METHODS FOR ESTIMATING GROUNDWATER RECHARGE FROM A LAKE.
Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
For primary bibliographic entry see Field 2F.
W90-09482

USING VERTICAL ELECTRICAL SOUNDINGS TO ACCURATELY MAP A BURIED CHANNEL IN COASTAL PLAIN SEDIMENTS.
Environmental Resources Management, Inc., Exton, PA.
G. R. Emilsson, and P. R. Morin.
IN: Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues. October 17-19, 1989, Kitchener, Ontario, Canada. National Water Well Association, Dublin, Ohio. 1989. p 41-54, 5 fig, 2 tab, 2 ref.

Descriptors: *Buried rivers, *Data acquisition, *Electrical sounding, *Geohydrology, *Geophysical exploration, *Mapping, Clays, Data interpretation, Drilling, Geophysics, Groundwater level, Monitoring wells, New Jersey, Subterranean streams.

A case history is presented which illustrates the application of vertical electrical soundings to map the depth to a confining clay layer at a hazardous waste site in central New Jersey. Here medium to coarse sand, silt and gravel deposits overlie a stiff clay stratum. Boring logs obtained from monitoring wells installed during Phase I and II remedial investigations show differences in the elevations of the top of the clay layer, suggesting that a channel has been eroded into the clay and later buried by the coarse deposits. Movement of shallow groundwater at the site was believed to be influenced by this channel. Vertical electrical soundings were chosen to map the depth to the clay over drilling and other geophysical methods because of the relatively low cost of the technique. The soundings, using the Schlumberger configuration, were interpreted using a one-dimensional forward/inverse modeling computer program. The interpretations of the soundings were used to place monitoring wells for the Phase III investigation. The monitoring well borings confirmed the geophysical interpretation. The depth of the clay layer as interpreted from the geologist's log of a monitoring well placed in the center axis of the buried trough differed from the geophysical interpretation of the clay layer depth by less than two feet. (See also W90-09479) (Author's abstract)
W90-09483

7C. Evaluation, Processing and Publication

SIMULATION OF INTERACTIONS BETWEEN MIGRATING WHALES AND POTENTIAL OIL SPILLS.
Applied Science Associates, Inc., Narragansett, RI.
For primary bibliographic entry see Field 5B.
W90-08730

GROUND WATER MODELING IN MULTI-LAYER AQUIFERS: UNSTEADY FLOW.
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-08750

PREDICTING THE OCCURRENCE OF ACID MINE DRAINAGE IN THE ALLEGHENIAN COAL-BEARING STRATA OF WESTERN PENNSYLVANIA; AN ASSESSMENT BY SIMULATED WEATHERING (LEACHING) EXPERIMENTS AND OVERBURDEN CHARACTERIZATION.
Pennsylvania State Univ., University Park. Materials Research Lab.
For primary bibliographic entry see Field 5B.
W90-08758

KANAWHA RIVER BASIN WATER QUALITY MODELING.
Hydrologic Engineering Center, Davis, CA.
For primary bibliographic entry see Field 5G.
W90-08764

GLOBAL SNOW DEPTH CLIMATOLOGY.
Air Force Environmental Technical Applications Center, Scott AFB, IL.
For primary bibliographic entry see Field 2C.
W90-08765

SEASONAL SNOWFALL STATISTICS FOR SELECTED STATIONS.
Air Force Environmental Technical Applications Center, Scott AFB, IL.
For primary bibliographic entry see Field 2C.
W90-08766

COMPUTER APPLICATIONS IN WATER SUPPLY. VOLUME 1: SYSTEMS ANALYSIS AND SIMULATION.
For primary bibliographic entry see Field 5F.
W90-08776

GRADIENT ALGORITHM FOR THE ANALYSIS OF PIPE NETWORKS.
Bologna Univ. (Italy). Ist. di Costruzioni Idrauliche.
For primary bibliographic entry see Field 5F.
W90-08777

COMPARISON OF COLEBROOK-WHITE AND HAZEN-WILLIAMS FLOW MODELS IN REAL-TIME WATER NETWORK SIMULATION.
Durham Univ. (England). School of Engineering and Applied Science.
For primary bibliographic entry see Field 5F.
W90-08778

COMPARISON OF THE GRADIENT METHOD WITH SOME TRADITIONAL METHODS FOR THE ANALYSIS OF WATER SUPPLY DISTRIBUTION NETWORKS.
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W90-08779

NETWORK ANALYSIS--THE REAL STORY.

WRc Engineering, Swindon (England).
For primary bibliographic entry see Field 5F.
W90-08780

NETWORK ANALYSIS: A USER'S VIEWPOINT.
Haiste Ltd., Leeds (England).
For primary bibliographic entry see Field 5F.
W90-08782

OPERATIONAL EXPERIENCE OF GINAS AND WATNET.
Ward, Ashcroft and Parkman, Chester (England).
For primary bibliographic entry see Field 5F.
W90-08783

LONDON'S WATER SUPPLY IN THE 21ST CENTURY--COMPUTER MODELLING ASPECTS.
Thames Water Authority, Reading (England). Planning Dept.
For primary bibliographic entry see Field 5F.
W90-08784

SYSTEMS APPROACH TO EXTENDED GINAS APPLICATIONS.
Leicester Polytechnic (England). Water Control Unit.
For primary bibliographic entry see Field 5F.
W90-08785

USE OF SIMULATION MODELS OF WATER SUPPLY SYSTEMS--PROCESSING OF INPUT AND OUTPUT DATA.
Laboratorio Nacional de Engenharia Civil, Lisbon (Portugal).
For primary bibliographic entry see Field 5F.
W90-08786

APPLICATIONS OF MICROCOMPUTERS IN THE DESIGN AND OPTIMISATION OF WATER SUPPLY AND DISTRIBUTION SYSTEMS IN DEVELOPING COUNTRIES.
City Univ., London (England). Thermo-Fluids Engineering Research Center.
For primary bibliographic entry see Field 5F.
W90-08787

WATER SUPPLY APPLICATIONS PROGRAMS IN AN OPERATIONS ENVIRONMENT.
Leicester Polytechnic (England). Water Control Unit.
For primary bibliographic entry see Field 5F.
W90-08788

TIME SERIES MODELLING OF WATER DEMAND--A STUDY ON SHORT-TERM AND LONG-TERM PREDICTIONS.
Instituto de Ingenieria Cibernetica, Barcelona (Spain).
For primary bibliographic entry see Field 5F.
W90-08789

APPLICATIONS OF TIME SERIES ANALYSIS TO WATER DEMAND PREDICTION.
Tongji Univ., Shanghai (China). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5F.
W90-08790

AUTOMATED METHOD FOR PROCESSING CONSUMER DEMAND INFORMATION WITH REFERENCE TO WATER DISTRIBUTION SYSTEM MODELLING--THE DEVELOPMENT OF A DEMAND ALLOCATION AND MAPPING PACKAGE (DAMP).
Severn-Trent Water Authority (England).
For primary bibliographic entry see Field 5F.
W90-08791

STATE ESTIMATION AND LEAK DETECTION IN WATER NETWORKS.
Ecole Nationale Superieure des Mines de Paris, Fontainebleau (France). Centre d'Automatique et Informatique.
For primary bibliographic entry see Field 5F.
W90-08792

COMPARISON OF THREE REAL-TIME STATE ESTIMATION METHODS FOR ON-LINE MONITORING OF WATER DISTRIBUTION SYSTEMS.
Durham Univ. (England). School of Engineering and Applied Science.
For primary bibliographic entry see Field 5F.
W90-08793

USE OF THERMODYNAMIC PUMP TESTING IN CONJUNCTION WITH WATER DISTRIBUTION NETWORK MODELS.
Severn-Trent Water Authority, Birmingham (England). Western Div.
For primary bibliographic entry see Field 5F.
W90-08794

FAULT ANALYSIS AND FLUID TRANSIENT SUPPRESSION IN PIPELINES AND NETWORKS.
City Univ., London (England). Thermo-Fluids Engineering Research Center.
For primary bibliographic entry see Field 5F.
W90-08795

SIMULATION OF TRANSIENT PHENOMENA IN INTERNAL FLOW SYSTEMS.
Warwick Univ., Coventry (England). Dept. of Engineering.
For primary bibliographic entry see Field 5F.
W90-08796

COMPUTER APPLICATIONS IN WATER SUPPLY. VOLUME 2: SYSTEMS OPTIMIZATION AND CONTROL.
For primary bibliographic entry see Field 5F.
W90-08799

TELEMETRY SYSTEM CONTROL: THE RTK KERNEL--A GENERAL SOLUTION.
Information Processing Ltd., Bath (England).
For primary bibliographic entry see Field 5F.
W90-08801

LOCAL INTELLIGENT PUMPING--A STANDARD APPROACH.
SPP Controls Ltd., Reading (England).
For primary bibliographic entry see Field 5F.
W90-08802

CONFIDENCE LIMIT ANALYSIS IN WATER SYSTEMS.
Trent Polytechnic, Nottingham (England).
For primary bibliographic entry see Field 5F.
W90-08803

OPERATIONS CONTROL SYSTEMS IN THE WATER INDUSTRY: WHAT, HOW, AND WHERE TO.
Holloway Associates, Weybridge (England).
For primary bibliographic entry see Field 5F.
W90-08804

REVIEW OF METHODOLOGIES FOR MODELLING AND CONTROL OF WATER SUPPLY.
Leicester Polytechnic (England). Water Control Unit.
For primary bibliographic entry see Field 5F.
W90-08805

OVERVIEW OF IMPORTANT ISSUES IN OPERATIONAL FLOOD CONTROL.
Politechnika Warszawska (Poland). Inst. of Automatic Control.

For primary bibliographic entry see Field 4A.
W90-08806

ROBUST DIGITAL CONTROL OF VALVES IN A LARGE WATER NETWORK.
Instituto de Ingenieria Cibernetica, Barcelona (Spain).
For primary bibliographic entry see Field 5F.
W90-08807

APPLICATIONS REVIEW OF MODELLING AND CONTROL OF WATER SUPPLY AND DISTRIBUTION SYSTEMS.
Leicester Polytechnic (England). Water Control Unit.
For primary bibliographic entry see Field 5F.
W90-08808

MODELLING OF WATER TREATMENT WORKS.
Halcrow (William) and Partners, Swindon (England).
For primary bibliographic entry see Field 5F.
W90-08809

SIMPLIFICATION OF WATER SUPPLY DISTRIBUTION SYSTEMS FOR OPTIMAL OPERATIONS.
Tongji Univ., Shanghai (China). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5F.
W90-08810

SUBOPTIMAL APPROACH TO SCHEDULING OF RESERVOIR LEVELS FOR A MULTI-RESERVOIR WATER DISTRIBUTION NETWORK.
Politechnika Warszawska (Poland). Inst. of Automatic Control.
For primary bibliographic entry see Field 5F.
W90-08811

OPTIMAL SCHEDULING OF A CLASS OF WATER SUPPLY SYSTEMS CONTAINING ONLY FIXED SPEED PUMPS.
Leicester Polytechnic (England). Water Control Unit.
For primary bibliographic entry see Field 5F.
W90-08812

OPTIMIZATION OF URBAN WATER DISTRIBUTION SYSTEMS.
Tongji Univ., Shanghai (China). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5F.
W90-08813

PUMP SCHEDULING IN WATER SUPPLY: MORE THAN A MATHEMATICAL PROBLEM.
WRc Engineering, Swindon (England).
For primary bibliographic entry see Field 5F.
W90-08814

PRACTICAL APPLICATION OF COMPUTER AIDED SIMULATION AND OPTIMIZATION TO THE LEICESTER WATER SUPPLY MELBOURNE AQUEDUCTS SYSTEM.
Severn-Trent Water Authority, Leicester (England). Eastern Div.
For primary bibliographic entry see Field 5F.
W90-08815

COMPUTER TECHNIQUES FOR ON-LINE CONTROL OF WATER SUPPLY NETWORKS.
Cambridge Univ. (England). Dept. of Engineering.
For primary bibliographic entry see Field 5F.
W90-08816

REAL-TIME FORECASTING AND CONTROL FOR WATER DISTRIBUTION.
Heriot-Watt Univ., Edinburgh (Scotland). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.

W90-08817

OPTIMAL OPERATION OF WATER SYSTEMS.
Sociedad General de Aguas de Barcelona (Spain).
For primary bibliographic entry see Field 5F.
W90-08818

OPTIMAL CONTROL OF THE WEST PARISIAN AREA WATER SUPPLY NETWORK.
Lyonnaise des Eaux, Paris (France).
For primary bibliographic entry see Field 5F.
W90-08819

COMPUTER CONTROL OF WATER SUPPLY AND DISTRIBUTION SYSTEMS: STRUCTURES, ALGORITHMS AND MANAGEMENT.
Leicester Polytechnic (England). Water Control Unit.
For primary bibliographic entry see Field 5F.
W90-08820

DISTRIBUTION SYSTEM MANAGEMENT AND CONTROL OPTIMISATION.
North Surrey Water Co., Staines (England).
For primary bibliographic entry see Field 5F.
W90-08821

VARIABLE LANDSCAPE AGGREGATION FOR LARGE SCALE WATERSHED EVAPOTRANSPIRATION ESTIMATES.
Montana Univ., Missoula. School of Forestry.
For primary bibliographic entry see Field 2D.
W90-08830

CLASSIFICATION AND SPATIAL MAPPING OF RIPARIAN HABITAT WITH APPLICATIONS TO MODELING INSTREAM IMPACTS OF AGRICULTURAL NONPOINT SOURCE POLLUTION.
Idaho Univ., Moscow. Dept. of Plant, Soil and Entomological Sciences.
For primary bibliographic entry see Field 5C.
W90-08850

VALIDATION AND SENSITIVITY ANALYSIS OF THE STREAM NETWORK TEMPERATURE MODEL ON SMALL WATERSHEDS IN NORTHEAST OREGON.
EA Engineering, Science, and Technology, Inc., Lafayette, CA.
For primary bibliographic entry see Field 2E.
W90-08862

WATER QUALITY MODELING AND TRANSPORT ANALYSIS OF HEAVY METALS IN THE CLARK FORK RIVER.
AScI Corp., Athens, GA.
For primary bibliographic entry see Field 5B.
W90-08876

STRATIFIED FLOOD FREQUENCY ANALYSIS.
State Univ. of New York Coll. of Environmental Science and Forestry, Syracuse.
For primary bibliographic entry see Field 2E.
W90-08878

ESTIMATING MEAN MONTHLY STREAMFLOW AT UNGAGED SITES IN WESTERN MONTANA.
Geological Survey, Helena, MT.
C. Parrett, and K. D. Cartier.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 589-598, 2 fig, 4 tab, 15 ref.

Descriptors: *Headwaters hydrology, *Rainfall-runoff relationships, *Runoff, *Streamflow forecasting, Data interpretation, Mathematical equa-

Field 7—RESOURCES DATA

Group 7C—Evaluation, Processing and Publication

tions, Mathematical studies, Montana, Regression analysis, Stream gages.

Three methods for estimating mean monthly streamflow at ungaged sites in western Montana are described. The first method, based on multiple-regression equations, relates mean monthly streamflow to various basin and climatic variables; standard errors range from 43 to 72%. The second method, based on regression equations, relates mean monthly streamflow to channel width; standard errors range from 46 to 75%. The third method requires 12 once-monthly streamflow measurements at an ungaged site. These measurements are correlated with concurrent streamflows at some nearby gaged site, and the resulting relation is used to estimate the mean monthly streamflow at the ungaged site; standard errors range from 21 to 46%. A procedure for weighting individual estimates, based on variance and degree of independence of the three estimating methods, was also developed; standard errors range from 16 to 26% when all three methods are used. (See also W90-08822) (Author's abstract)
W90-08881

HYDROLOGIC SIMULATION TECHNIQUES APPLIED TO WATER MANAGEMENT IN MONTANA.
Montana Dept. of Natural Resources and Conservation, Helena.
For primary bibliographic entry see Field 2E.
W90-08882

MODELING RUNOFF FROM SAGEBRUSH RANGELANDS ALONG A CLIMATIC GRADIENT IN SOUTHWEST IDAHO.
Agricultural Research Service, Boise, ID. Northwest Watershed Research Center.
For primary bibliographic entry see Field 2E.
W90-08883

PREDICTION OF ANNUAL WATER YIELD FROM LAND MANAGEMENT ACTIVITIES.
Colorado State Univ., Fort Collins.
For primary bibliographic entry see Field 3B.
W90-08884

STOCHASTIC MODELING OF LAKE LEVELS FOR A MANAGEMENT DECISION.
Forest Service, Washington, DC.
For primary bibliographic entry see Field 2H.
W90-08885

REVISED EDITION OF A COMPUTERIZED PLANKTON COUNTER FOR PLANKTON, PERIPHYTON, AND SEDIMENT DIATOM ANALYSES.
National Museum of Natural Sciences, Ottawa (Ontario). Botany Div.
P. B. Hamilton.
Hydrobiologia HYDRB8, Vol. 194, No. 1, p 23-30, 1990. 2 fig, 8 ref.

Descriptors: *Computer programs, *Data interpretation, *Plankton, *Species composition, BASIC, Chi square analysis, D'Agostinos test, Data processing, Diatoms, Periphyton, Statistical analysis.

A revised computer counting program is presented with faster processing and more efficient features to enhance counting precision. The program is now capable of counting epilithic communities and sediment samples for diatom analysis. This version (2.3) is available for APPLE, IBM, TANDY-RADIOSHACK, and HYPERION systems using standard BASIC commands. New improvements include density and biovolume calculations, a Chi square transect test for randomness, D'Agostino's test for a normal taxa distribution and a three file output with raw and processed data. (Author's abstract)
W90-08896

APPLICATION OF AN ENERGY COMBINATION MODEL FOR EVAPORATION FROM SPARSE CANOPIES.

Trent Univ., Peterborough (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2D.
W90-08926

COMPARISON OF BOWEN RATIO AND AERODYNAMIC ESTIMATES OF EVAPOTRANSPIRATION.
Laboratoire de Bioclimatologie, Peronne (France).
For primary bibliographic entry see Field 2D.
W90-08928

HIGH-INTENSITY RAINFALL RATE DETERMINATION FROM TIPPING-BUCKET RAIN GAUGE DATA.
Agricultural Research Service, Florence, SC. Coastal Plains Soil and Water Conservation Research Center.
For primary bibliographic entry see Field 2B.
W90-08931

NUMERICAL MODEL FOR THE COMPUTATION OF RADIANCE DISTRIBUTIONS IN NATURAL WATERS WITH WIND-ROUGHENED SURFACES.
Joint Inst. for the Study of the Atmosphere and Ocean, Seattle, WA.
For primary bibliographic entry see Field 2H.
W90-08966

MODELING IN SITU PHYTOPLANKTON ABSORPTION FROM TOTAL ABSORPTION SPECTRA IN PRODUCTIVE INLAND MARINE WATERS.
Washington Univ., Seattle. School of Oceanography.
For primary bibliographic entry see Field 2L.
W90-08967

GEOGRAPHIC INFORMATION SYSTEMS, DATA, AND WATER RESOURCES.
Minnesota Univ., Minneapolis. Dept. of Geography.
D. A. Brown, and P. J. Germehl.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 14-17, Fall 1989. 11 fig, 1 tab, 6 ref.

Descriptors: *Data interpretation, *Geographic information systems, Hydrologic maps, Land use, Minnesota, Runoff.

Analysis of water resources data is increasingly being conducted with the assistance of Geographic Information Systems (GIS). This trend will likely increase because a growing amount of data were being archived in GIS files. Three data handling methods are analyzed for use in a GIS analysis of land-cover change impacts on runoff. A universe of 2560 point samples was analyzed to provide runoff calculations that would serve as a comparison base to evaluate different attribute logic systems. The attribute logics evaluated are two variations of tag and one of count. The test site is a two mile by five mile area of Dakota County, Minnesota, and raster GIS maps of soil hydrologic groups and two plausible land covers were prepared. The count method for handling the generalization of data produced results that were substantially closer to the characteristics of the universe that either of the tags approaches. To minimize error in assessment of water resources with a GIS, analysts should start with primary data, control all phases of data manipulation, and use count methods to abstract large-area data. (Author's abstract)
W90-08971

LANDSCAPE ASSESSMENT OF SOIL EROSION AND NONPOINT SOURCE POLLUTION.
Minnesota Univ., St. Paul. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2J.
W90-08972

LAKE MIXING DYNAMICS AND WATER QUALITY MODELS.

Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 5G.
W90-08983

HYDROLOGIC MODEL FOR MINNESOTA PEATLANDS.
Minnesota Univ., St. Paul. Dept. of Forest Resources.
For primary bibliographic entry see Field 2H.
W90-08987

MODELLING THE EFFECTS OF TIED-RIDGING ON WATER CONSERVATION AND CROP YIELDS.
Texas Agricultural Experiment Station, Temple. Blackland Research Center.
For primary bibliographic entry see Field 3F.
W90-09011

MICROCOMPUTER FOR ON-LINE CONTROL AND OPERATION OF CLOSED-CONDUIT IRRIGATION SYSTEMS: AN ECONOMICAL ASSESSMENT.
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
For primary bibliographic entry see Field 3F.
W90-09015

NUMERICAL KINEMATIC WAVE MODEL FOR BORDER IRRIGATION.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W90-09017

COMPLEX MODEL FOR ENVIRONMENTAL QUALIFYING.
Budapesti Mueszaki Egyetem (Hungary). Inst. of Water Management.
For primary bibliographic entry see Field 2B.
W90-09094

ESTIMATING THE PRECISION OF GROUND-WATER ELEVATION DATA.
Illinois State Psychiatric Inst., Chicago. Biometric Lab.
For primary bibliographic entry see Field 2F.
W90-09135

QUANTITATIVE ANALYSIS FOR THE CLEANUP OF HYDROCARBON-CONTAMINATED SOILS BY IN-SITU SOIL VENTING.
Shell Development Co., Houston, TX.
For primary bibliographic entry see Field 5G.
W90-09142

SIMULATING COSTS OF FLOODING UNDER ALTERNATIVE POLICIES FOR THE SACRAMENTO-SAN JOAQUIN RIVER DELTA.
California Univ., Davis. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 4A.
W90-09154

FRACTAL INTERPRETATION OF THE MAINSTREAM LENGTH-DRAINAGE AREA RELATIONSHIP.
Montreal Univ. (Quebec). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W90-09158

PERIODIC COVARIANCE STATIONARITY OF MULTIVARIATE PERIODIC AUTOREGRESSIVE MOVING AVERAGE PROCESSES.
Middle East Technical Univ., Ankara (Turkey). Dept. of Statistics.
T. A. Ula.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 855-861, May 1990. 19 ref.

Descriptors: *Hydrologic models, *Model studies, *Regression analysis, *Statistical analysis, *Statistics, *Stream discharge, Autoregressive moving average processes, Mathematical studies, Multivariate analysis, PARMA model, Periodic autoregressive moving average p, Seasonal variation, Univariate analysis.

Periodic (covariance) stationarity conditions for multivariate periodic autoregressive moving average (PARMA) processes, as applied to the modeling of univariate and multivariate seasonal hydrologic processes (mainly streamflow series), were investigated. It is concluded that a necessary and sufficient condition for the periodic stationarity of a multivariate periodic process was the (covariance) stationarity of the lumped vector process which contains the periodic vectors as its elements. It is shown that for univariate and multivariate PARMA processes, even with periodically varying orders, the lumped process is a multivariate autoregressive moving average (ARMA) process, the stationarity conditions of which are readily available. Periodic stationarity conditions for the multivariate PARMA (1,1) process are explicitly obtained, which apply for all PARMA (1,q) processes. It is shown that the periodic stationarity of a periodic process always implies the stationarity of the aggregated process, the sum of the periodic vectors. The reverse is not proved or disproved. However, it is shown to be true for PAR(1) and PARMA(1,1) processes. (Author's abstract)16 May 90
W90-09160

STOCHASTIC INTERPOLATION OF RAINFALL DATA FROM RAIN GAGES AND RADAR USING COKRIGING. II. RESULTS.
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 2B.
W90-09165

REVIEW OF GEOSTATISTICS IN GEOHYDROLOGY: I. BASIC CONCEPTS.
American Society of Civil Engineers, New York.
For primary bibliographic entry see Field 2F.
W90-09187

REVIEW OF GEOSTATISTICS IN GEOHYDROLOGY: II. APPLICATIONS.
American Society of Civil Engineers, New York.
For primary bibliographic entry see Field 2F.
W90-09188

MELLIN TRANSFORM APPLIED TO UNCERTAINTY ANALYSIS IN HYDROLOGY/HYDRAULICS.
Wyoming Water Research Center, Laramie.
For primary bibliographic entry see Field 8B.
W90-09189

LINEAR WATER-SUPPLY PIPELINE CAPACITY EXPANSION MODEL.
Lower Colorado River Authority, Austin, TX. Water and Wastewater Utilities Program.
For primary bibliographic entry see Field 8B.
W90-09190

TEMPORAL VARIATIONS IN BEDLOAD TRANSPORT RATES ASSOCIATED WITH THE MIGRATION OF BEDFORMS.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2J.
W90-09206

SOME ASPECTS OF DAILY RAINFALL DISTRIBUTION OVER INDIA DURING THE SOUTH-WEST MONSOON SEASON.
Indian Inst. of Tropical Meteorology, Poona.
For primary bibliographic entry see Field 2B.
W90-09222

RIPARIAN WOODY PLANT COMMUNITY OF REGULATED RIVERS IN EASTERN ENGLAND.

Essex Univ., Colchester (England). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-09252

TROPICAL CYCLONE SIMULATIONS WITH THE BETTS CONVECTIVE ADJUSTMENT SCHEME. PART I: MODEL DESCRIPTION AND CONTROL SIMULATION.
North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W90-09303

TROPICAL CYCLONE SIMULATIONS WITH THE BETTS CONVECTIVE ADJUSTMENT SCHEME. PART II: SENSITIVITY EXPERIMENTS.
North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W90-09304

TROPICAL PRECIPITATION RATES DURING SOP-1, FGGE, ESTIMATED FROM HEAT AND MOISTURE BUDGETS.
Purdue Univ., Lafayette, IN. Dept. of Earth and Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W90-09305

REVERSALS IN EVOLVING RAINDROP SIZE DISTRIBUTIONS DUE TO THE EFFECTS OF COALESCENCE AND BREAKUP.
Trinity Coll., Hartford, CT. Dept. of Mathematics.
For primary bibliographic entry see Field 2B.
W90-09327

POND SIZING FOR RATIONAL FORMULA HYDROGRAPHS.
Pennsylvania State Univ., University Park. Environmental Resources Research Inst.
For primary bibliographic entry see Field 4A.
W90-09349

SATURATION-BASED MODEL OF RELATIVE WETNESS FOR WETLAND IDENTIFICATION.
East Carolina Univ., Greenville, NC. Dept. of Geography and Planning.
For primary bibliographic entry see Field 2H.
W90-09357

SURFACE AND SUBSURFACE DRAINAGE SIMULATIONS FOR A CLAYPAN SOIL.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 4A.
W90-09362

ANALYTICAL CLOSED BORDER IRRIGATION MODEL: I. THEORY.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W90-09363

ANALYTICAL CLOSED BORDER IRRIGATION MODEL: II. EXPERIMENTAL VERIFICATION.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W90-09364

SOLUTE INPUT INTO GROUNDWATER FROM SANDY SOILS UNDER ARABLE LAND AND CONIFEROUS FOREST: DETERMINATION OF AREA-REPRESENTATIVE MEAN VALUES OF CONCENTRATION.
Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W90-09366

SENSITIVITY OF PENMAN ESTIMATES OF EVAPORATION TO ERRORS IN INPUT DATA.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2D.
W90-09367

MATHEMATICAL MODELING OF THE COMBINED SEWER SYSTEM.
Syracuse Univ., NY. Dept. of Civil and Environmental Engineering.
S. J. Nix.
IN: Control and Treatment of Combined-Sewer Overflows. Van Nostrand Reinhold, New York. 1990. p 23-78, 21 fig, 5 tab, 36 ref.

Descriptors: *Combined sewer overflows, *Mathematical models, *Model studies, *Rainfall-runoff relationships, *Storm runoff, *Storm wastewater, *Urban hydrology, Computer models, Simulation analysis, Storm Water Management Model, Storm-overflow sewers.

A combined sewer system is a complex system subjected to the dynamic stimuli of precipitation, runoff pollution loads, and sanitary wastes. The system response is a random series of overflows to a receiving water containing various levels of pollutant loads. The interaction between the combined sewer overflow (CSO) and the equally dynamic receiving water increases the complexity. The use of deterministic mathematical models to simulate the behavior of the combined sewer systems, is discussed. By replicating the system, a model can answer questions that would be impractical to answer through field measurements and observations. There are several models available to simulate the behavior of combined sewer systems. None are necessarily better than others; some just fit certain needs better than others. The simpler models are more appropriate for quick, preliminary estimates of CSO volumes and pollutant loads (usually on an annual basis). The more complicated models are better suited to detailed planning and design work. The bulk of this chapter is devoted to a discussion of the Storm Water Management Model (SWMM), a large, complex model capable of simulating the movement of precipitation and pollutants from the ground surface through pipe and channel networks, storage/treatment units, and finally to receiving waters. The model may be run for a single event or on a continuous basis for extended periods of simulation time. SWMM is divided into several 'blocks' each designed to handle a separate phase of the runoff process or, if desired, operate independently. Some of the blocks (i.e., RUNOFF, TRANSPORT, EXTRAN, and STORAGE/TREATMENT) are computational blocks responsible for the hydrologic, pollutant generation and transport, and hydraulic calculations. Others (i.e, EXECUTIVE, GRAPH, COMBINE, RAIN, TEMP, and STATISTICS) perform various service functions. (See also W90-09375) (Lantz-PTT)
W90-09377

RECEIVING-WATER IMPACTS.
Limno-Tech, Inc., Ann Arbor, MI.
For primary bibliographic entry see Field 5G.
W90-09378

ACID RAIN CONTROL STRATEGIES FROM MULTIPLE LONG-RANGE TRANSPORT MODELS.
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
For primary bibliographic entry see Field 5G.
W90-09413

USE OF ATMOSPHERIC TRANSPORT PATTERN RECOGNITION TECHNIQUES IN UNDERSTANDING VARIATION IN PRECIPITATION CHEMISTRY.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W90-09422

Group 7C—Evaluation, Processing and Publication

APPLICABILITY OF PRINCIPAL COMPONENTS ANALYSIS FOR DETERMINING SOURCES OF WET DEPOSITION.
Geological Survey, Doraville, GA. Water Resources Div.
R. P. Hooper, and N. E. Peters.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 127-135, 5 fig, 2 tab, 7 ref.

Descriptors: *Acid rain, *Atmospheric chemistry, *Data interpretation, *Path of pollutants, *Precipitation, *Principal component analysis, *Water pollution sources, Air pollution, Sulfates, United States.

A principal components analysis (PCA) was performed on wet deposition data collected from 194 stations in the United States and its territories. Approximately 90% of the components derived were interpretable as either an acid, salt, or agriculture/soil association. In addition, a correction term was added to the new variables to place them on an absolute basis. This correction enables the total mass or the mass of any one solute to be apportioned among the identified components. The use of multi-solute components for determining trends or spatial distribution represents a significant improvement over single solute analysis in that these components are more directly related to the sources of the deposition. The total mass deposition due to the acidic component extends farther south than would have been expected from isopleth maps of SO4(2-) deposition, accounting for > 25% of the total deposition at > 85% of the stations. Only at some areas in the West (the Pacific Coast, Nevada, Utah, and northern Arizona), Puerto Rico, and American Samoa does the acid component account for < 25% of the deposition. This finding indicates that widespread importance of acid deposition despite the low deposition of sulfate. At sites where the acidic component is important and no natural source of acidity (e.g. volcanoes) exists, perturbation to the natural environment could be occurring. (See also W90-09408) (Lantz-PTT)
W90-09423

STOCHASTIC MODELING OF RAINFALL PROCESSES IN THE CENTRAL AFRICAN TROPICS.
Department of Water Affairs, Maseru (Lesotho).
For primary bibliographic entry see Field 2B.
W90-09425

SYSTEMATIC PARAMETER ESTIMATION STRATEGY FOR REFINING THE BIRKENES MODEL.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
J. W. Delleur, and F. J. Chang.
IN: Atmospheric Deposition. Proceedings of a Symposium held during the Third Scientific Assembly of the International Association of Hydrological Sciences at Baltimore, Maryland, May 1989. IAHS Publication No. 179, 1989. p 163-171, 3 fig, 4 tab, 5 ref.

Descriptors: *Acid rain, *Acidification, *Birkenes Model, *Data interpretation, *Estimating, *Model studies, *Path of pollutants, Automatic Parameter Calibration Technique, Forest watersheds, Norway, Performance evaluation, Regionalized Sensitivity Analysis, Statistical analysis.

The Birkenes model was developed using a simple two-reservoir geohydrochemical conceptual model for a forested catchment in southernmost Norway, for predicting the acidification of soils and freshwater. Although the model structure is rather simple and general, its application to a certain watershed requires that the values of its parameters be made specific for the given situation. Since the accuracy of the model performance depends upon the adequacy of the estimation of its parameters, the availability of a reliable parameter estimation technique will dominate its usefulness in future applications. An efficient automatic procedure has

been found for use with an appropriate systematic optimization technique. However, automatic procedures have some inherent difficulties to overcome, such as the interdependence of some of the parameters and the uncertainty in finding the global optimum in the presence of possible local optima for the objective function surface. In an attempt to overcome these difficulties, a systematic parameter estimation strategy was proposed which consists of a Regionalized Sensitivity Analysis (RSA) followed by an Automatic Parameter Calibration Technique (APCT). The RSA eliminates the insensitive parameters and establishes the appropriate range of values for each remaining parameter. Consequently, the optimal solution is more likely to be obtained by an APCT method. When implemented for the Birkenes model, the APCT procedure becomes the main program and the model is modified to a subroutine. The parameters of the refined Birkenes model can then be calibrated automatically without manual adjustment and a better model performance obtained. In an attempt to overcome the problems of inherent nonlinear properties in the model structure and multiple local optima of the objective function surface, it is recommended that the regionalized sensitivity analysis be executed to eliminate the insensitive parameters and establish the favorable simulation ranges of the sensitive parameters before the APCT is performed. (See also W90-09408) (Lantz-PTT)
W90-09427

APPLICATION OF THE STEP-DURATION OROGRAPHIC INTENSIFICATION COEFFICIENT METHOD TO THE ESTIMATION OF OROGRAPHIC EFFECTS ON RAINFALL.
Hohai Univ., Nanjing (China). Dept. of Hydrology.
For primary bibliographic entry see Field 2B.
W90-09437

EPA SUPERFUND DATA BASES ON THE OCCURRENCE AND DISTRIBUTION OF ORGANOCHLORINE PESTICIDES IN WATERS AND SOILS FROM HAZARDOUS WASTE SITES.
Viar and Co., Alexandria, VA.
H. McCarty, W. Eckel, P. Issacson, M. Lynch, and J. Fisk.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 173-182, 6 tab, 3 ref, EPA Contract 68-01-7235.

Descriptors: *Chlorinated hydrocarbons, *Databases, *Halogenated pesticides, *Hazardous waste disposal, *Hazardous wastes, *Path of pollutants, *Pesticides, *Superfund, *Waste disposal, *Water pollution sources, Data collections, Distribution patterns, Frequency distribution, Organic compounds, Soil contamination.

Environmental samples processed through the CLP (Contract Laboratory Program) are routinely analyzed for over 125 organic contaminants, including 20 organochlorine pesticides. A modified version of EPA Method 608 is used for pesticide analysis. Two databases contain the pesticide data generated by the CLP: the CLP Statistical Database (STAT), and the CLP Analytical Results Database (CARD). STAT contains information on the representative selection (approximately 10 percent) of all the samples analyzed by the CLP from 1980-1986. CARD contains information on virtually all of the samples analyzed by the CLP since November 1987 to the present. The two databases can be used to evaluate the frequency of occurrence and the concentrations of the pesticides, the differences over time over sampling strategies and sampling results, efficiency and reliability of the analytical method, the detection limits, and the phenomenon of co-occurrence of the pesticides. The occurence of organochlorine pesticides at known or suspected hazardous waste sites is considerably lower than the occurrence of the other classes of organic compounds examined by the EPA's Superfund Program. While the data contained in these databases is censored, frequency distributions may be useful in determining which

pesticide analyses would benefit most from lower reporting limits, method improvements, and others. (See also W90-09440) (Lantz-PTT)
W90-09453

REGIONAL ASSESSMENT OF PESTICIDE EXPOSURE USING STORET DATA.
George Mason Univ., Fairfax, VA. Dept. of Biology.
L. J. Phillips, and G. F. Birchard.
IN: Pesticides in Terrestrial and Aquatic Environments. Proceedings of a National Research Conference, May 11-12, 1989. Virginia Water Resources Research Center, Blacksburg, VA. 1989. p 183-193, 1 fig, 5 tab, 13 ref.

Descriptors: *Data interpretation, *Path of pollutants, *Pesticides, *STORET database, *Statistical analysis, Bioaccumulation, Fish, Great Lakes, Public health, Sediment contamination, Tissue analysis.

This project tests the hypothesis that different regions of the United States are subject to varying degrees of pesticide exposure, and provides a case study of the Great Lakes region. The U.S. EPA STORET database was used in hypotheses testing. Toxic substances accumulate in sediments and in fish tissues. The relative amounts of pesticide accumulated in the environment were considered indicative of the extent of human exposure, and the levels of pesticides in fish tissue and sediment were used as surrogates for human exposure. In the case study of the Great Lakes region a statistical formulation was used to compare the median of the Great Lakes region to the median of the highest ranked region for each of the same 15 pesticides in fish tissue and sediment for the same two time periods. The U.S. Geological Survey's 18 water resource regions were ranked one through eighteen in order of toxicity concentration of 15 pesticides. Rankings were not random but reflected actual variations among regions. The Great Lakes region was generally not the highest ranked region. The Lower Colorado region had the highest pooled pesticide rank for sediments in 1978 to 1981 and the highest pooled pesticide rank for both fish tissue and sediment in 1982 to 1987. The Missouri region had the highest pooled pesticide ranks for tissues in 1978 to 1981. (See also W90-09440) (Lantz-PTT)
W90-09454

SIMPLIFIED PC-BASED PROCESS-ORIENTED MODEL FOR EVALUATING GROUNDWATER CONTAMINATION POTENTIAL BY PESTICIDES.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W90-09473

USING VERTICAL ELECTRICAL SOUNDINGS TO ACCURATELY MAP A BURIED CHANNEL IN COASTAL PLAIN SEDIMENTS.
Environmental Resources Management, Inc., Exton, PA.
For primary bibliographic entry see Field 7B.
W90-09483

8. ENGINEERING WORKS

8A. Structures

SIMPLIFIED EARTHQUAKE ANALYSIS OF GATED SPILLWAY MONOLITHS OF CONCRETE GRAVITY DAMS.
California Univ., Berkeley.
A. K. Chopra, and H. Tan.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A207 080. Price codes: A08 in paper copy, A01 in microfiche. Technical Report SL-89-4, March 1989. Final Report. 155p, 16 fig, 11 tab, 14 ref, 3 append. Department of the Army Contract DAAG29-81-D-0100.

Descriptors: *Concrete dams, *Dam design, *Dams, *Earthquakes, *Gates, *Spillways, Concrete technology, Finite element method, Gravity dams, Mathematical studies, Model studies, Stress.

The simplified procedure for earthquake analysis of concrete gravity dams previously developed for nonoverflow monoliths was extended to gated spillway monoliths. Standard data are presented for the vibration properties of such monoliths and for all parameters that are required in the analysis procedure. The use of the simplified analysis procedure and of a computer program that facilitates implementation of the procedure is illustrated with examples. Based on results of finite element analyses, it was concluded that: (1) the fundamental vibration period and mode shape of a spillway monolith is not influenced significantly by the bridge, gate, or foot bucket, but the effects of the pier may not be negligible; and (2) an equivalent two-dimensional system of unit thickness along the dam axis, with the mass and elastic modulus of the monolith kept at their actual values, but those of the pier reduced by the ratio of monolith thickness to pier thickness, is satisfactory for computing the fundamental vibration period and mode shape of the system. The equivalent two-dimensional system representing a gated spillway monolith is assumed to be supported on a viscoelastic half-plane and impounding a reservoir of water, possibly with alluvium and sediments at the bottom. Although the equivalent single-degree-of-freedom (SDF) system representation is valid for dams of any cross-section, the upstream face of the dam was assumed to be vertical only for the purpose of evaluating the hydrodynamic terms in the governing equations. The standard data presented in the report are also based on this assumption, which is reasonable for actual concrete gravity dams because the upstream face is vertical or almost vertical for most of the height, and the hydrodynamic pressure on the dam face is insensitive to small departures which are near the base of the dam, which is usually the case. (Lantz-PTT)
W90-08762

WYNOOCHEE DAM FOUNDATION REPORT.
Army Engineer District, Seattle, WA. Seattle District.
R. D. Eckerlin, and D. Larson.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A207 425. Price codes: A11 in paper copy, A01 in microfiche. 1988. 239p, 17 fig, 7 tab, 10 ref, 4 append.

Descriptors: *Dam foundations, *Dam stability, *Grout, *Wynoochee Dam, Dam construction, Dam inspection, Dams, Performance evaluation, Reservoirs, Wynoochee Lake.

The multipurpose Wynoochee Lake project located on the Wynoochee River, Washington consists of a dam, reservoir, outlet works, and fish facilities and provides industrial water supply, flood control, recreation, irrigation and enhancement of fisheries. Wynoochee Dam spans a narrow, near vertical-walled rock canyon and rises 50 ft above the canyon lip, impounding a reservoir 4.4 miles long at normal full pool elevation 800 ft. The 175-ft high concrete gravity section of the dam is founded on basaltic bedrock. Wynoochee Lake project was proposed in House Document 601 and authorized by Public Law. Preliminary investigations began in 1964 and final siting was made in 1965. Detailed foundation investigation was completed in 1967. No serious foundation problems relating to foundation stability were anticipated prior to, or developed during, construction. Only minor structural defects were found in the foundation which were readily corrected through standard bedrock foundation preparation and reinforcement techniques. Grout injection and drain hole seepage indicate that the foundation is generally tight. In general, the foundation of the dam is excellent. The lack of control over contractor blasting procedures resulted in extra excavation in some cases and redesign of project elements in others. As a result of the Wynoochee experience, the Seattle District of Corps of Engineers has established contract specifications which require Corps approval on general and specific blasting plans and where necessary, establish vibration control limits. Abutment and embankment seepage will be monitored for the life of the project under the dam safety program. (Lantz-PTT)
W90-08774

TURKWEL HYDROPOWER PROJECT NEAR THE KENYAN RIFT VALLEY (EAST AFRICA).
Grenoble-1 Univ. (France). Inst. de Recherches Interdisciplinaires de Geologie et de Mecanique.
For primary bibliographic entry see Field 8E.
W90-09036

SCALE MODEL OF THE LEAZ SLIPPAGE IN THE GENISSIAT RESERVOIR (ETUDE SUR MODELE REDUIT DU GLISSEMENT DE LEAZ DANS LA RETENUE DE GENISSIAT).
Compagnie Nationale du Rhone, Lyon (France).
J. Selmi, and F. Fruchart.
Houille Blanche HOBLAB, Vol. 1990, No. 1, p 61-71, 1990. 15 fig. English summary.

Descriptors: *Dam stability, *Dams, *France, *Hazard assessment, *Landslides, *Model studies, Aerial photography, Bank protection.

A potential landslide of approximately 350,000 cubic meters is located on the right bank of the Rhone, above the reservoir created by the Genissiat Dam, approximately 7 kilometers upstream from the built-up area of Bellegarde-sur-Valserine. This has led the Compagnie Nationale du Rhone to supervise the area constantly and to carry out various studies intended to draw up a set of urgent operating procedures in order to avoid any damage to the inhabitants. A scale model study (1/200 scale) was conducted to determine the consequences of a landslide on the Genissiat reservoir and on the town of Bellegarde-sur-Valserine and thus enable operating procedures to be clearly defined. In addition, a complementary study was undertaken on another potential landslide, of a lesser volume, located approximately 4.5 km upstream on the river near Bellegarde. The investigation indicates that monolithic slides of 100,000 cu m each may be expected. At the reservoir, the amplitude of the waves depends on the water volume and the speed of displacement. The effect of the waves can be reduced by decreasing the level of water from the actual 5 m to 2 m. The study demonstrated the important contribution made by the scale model. (Creskoff-PTT)
W90-09058

EVALUATING DAM SAFETY RETROFITS WITH UNCERTAIN BENEFITS: THE CASE OF MOHAWK DAM (WALHONDING RIVER, OHIO).
Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Engineering and Public Policy.
D. Resendiz-Carrillo, and L. B. Lave.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 1093-1098, May 1990. 5 fig, 2 tab, 17 ref. National Science Foundation Grant CES-86 19699.

Descriptors: *Dam stability, *Dams, *Economic evaluation, *Flood control, *Hydraulic structures, Cost-benefit analysis, Dam failure, Drowning, Earth dams, Flood damage, Flood forecasting, Flood hazard, Flood peak, Mohawk Dam, Ohio, Risk assessment, Walhonding River.

Mohawk Dam, built on the Walhonding River, Ohio in 1938, was designated a high-hazard dam, unable to survive a probable maximum flood, after a study 10 years ago. The dam height was raised, and the spillway was widened at a cost of $8 million. The smallest return period for the probable maximum flood of 10,800 cu m/s was 2 million years. During the 65-year record, the highest flow was about 2000 cu m/s, and the second highest flow was about 1500 cu m/s. Applying a previously proposed framework to select the social cost minimizing capacity of a dam, it was shown that Mohawk Dam had sufficient capacity that any retrofit had a social cost larger than expected benefits ($50 per year). Sensitivity analyses were performed adjusting the peak flow distribution, the costs of modification and downstream flood damage, as well as the possibility of loss of life. For any reasonable value of these variables, the structure was deemed safe with respect to extreme floods so that no retrofit was necessary. Using risk-based methods to evaluate the reservoir safety (National Research Council committee recommendations) confirmed these conclusions. (Cassar-PTT)
W90-09179

COST-EFFECTIVE ANALYSIS.
Moffa and Associates, Syracuse, NY.
For primary bibliographic entry see Field 6C.
W90-09380

GROUNDWATER CUTOFF WALLS: APPLICATION AT HAZARDOUS WASTE SITES.
Conestoga-Rovers and Associates, Waterloo (Ontario).
For primary bibliographic entry see Field 5G.
W90-09497

8B. Hydraulics

GENERALIZED DIFFUSION WAVE EQUATION WITH INERTIAL EFFECTS.
San Diego State Univ., CA. Dept. of Civil Engineering.
V. M. Ponce.
Water Resources Research WRERAQ, Vol. 26, No. 5, p 1099-1101, May 1990. 10 ref.

Descriptors: *Diffusion, *Hydraulics, *Hydrodynamics, *Model studies, *Runoff, *Surface flow, Channel flow, Flow equations, Froude number, Inertia, Mathematical studies, Unsteady flow.

A generalized diffusion wave equation, which includes inertial effects, was derived on the basis of the linear analogs of the complete equations of continuity and motion of free-surface flow. Specializations of this equation led to four types of diffusion wave models, depending on whether the inertia terms (local and convective) were excluded from or included in the formulation: (1) full inertial, (2) local inertial, (3) convective inertial, and (4) noninertial. Analysis of these diffusion wave models revealed substantial differences in their behavior, particularly with regard to the Froude number dependence of their hydraulic diffusivities. The full inertial and local inertial models had neutral Froude numbers, while the convective and noninertial models did not. In addition, the neutral Froude number of the full inertial model (wide channel with Chezy friction) simulated that of the complete equations. For low Froude number flows the noninertial model was shown to be a good approximation to the full inertial model. The noninertial model was a better approximation to the full inertial model than either local or convective models. (Author's abstract)
W90-09180

REVIEW OF GEOSTATISTICS IN GEOHYDROLOGY: I. BASIC CONCEPTS.
American Society of Civil Engineers, New York.
For primary bibliographic entry see Field 2F.
W90-09187

REVIEW OF GEOSTATISTICS IN GEOHYDROLOGY: II. APPLICATIONS.
American Society of Civil Engineers, New York.
For primary bibliographic entry see Field 2F.
W90-09188

MELLIN TRANSFORM APPLIED TO UNCERTAINTY ANALYSIS IN HYDROLOGY/HYDRAULICS.
Wyoming Water Research Center, Laramie.
Y. K. Tung.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 5, p 659-674, May 1990. 9 tab, 20 ref.

Descriptors: *Hydraulics, *Hydrology, *Mathematical studies, *Uncertainty, Channel flow, Flood routing, Mellin transform, Model studies, Risk as-

Field 8—ENGINEERING WORKS

Group 8B—Hydraulics

sessment, Sewers, Statistical analysis, Storm sewers.

The Mellin transform was applied to problems of uncertainty in hydraulic and hydrologic design and analysis. The technique is analytically convenient in determining the exact statistical moments of a random variable that is a function of several nonnegative independent random variables in a multiplicative form. Although the Mellin transform assumes that random model parameters are nonnegative and uncorrelated, these restrictions are not absolutely required. However, removal of the restrictions increases mathematical manipulation tremendously. The Mellin transform was applied to two examples: uncertainty analysis of flood travel time and risk analysis of storm sewer design. Methods like the mean value first-order second-moment method are unable to examine the impact of the form of the probability density function on the moments of the output. However, the Mellin transform and other integral transform techniques can provide an analytically easy tool to investigate the effect of probability density functions of input parameters on the statistical moments of the model output. The Mellin transform also yields an expression of uncertainty in model output that is amenable for analytical sensitivity analysis. (Cassar-PTT)
W90-09189

LINEAR WATER-SUPPLY PIPELINE CAPACITY EXPANSION MODEL.
Lower Colorado River Authority, Austin, TX. Water and Wastewater Utilities Program.
Q. W. Martin.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 5, p 675-690, May 1990. 3 fig, 17 ref.

Descriptors: *Hydraulics, *Model studies, *Pipelines, *Water distribution, *Water supply, Computer programs, Conveyance structures, Cost analysis, Design, Guadalupe River, Hydraulic design, Hydraulic engineering, Mathematical studies, PIPEX-I program, Pumping, San Antonio River, Texas, Water conveyance.

A computational methodology is described for establishing the approximate minimum-cost engineering design for the initial construction and subsequent capacity expansion of a linear water supply pipeline along a specified route. Dynamic programming algorithms are utilized to determine an optimal solution to an approximation of the complete design problem. The selected design specifies the number and size of pump stations and the length, diameter and pressure class of each staging interval over a planning period. Variations in pipe pressure class and the addition of parallel pipe are allowed along the individual sections of the pipeline route. This approximate least-cost design is the optimal design if parallel pipe is not allowed. The use of the algorithm is illustrated for a potential water conveyance pipeline in the San Antonio River Basin in Texas. (Author's abstract)
W90-09190

CHARACTERISTICS OF SELF-FORMED STRAIGHT CHANNELS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-09192

MATHEMATICAL MODELING OF THE COMBINED SEWER SYSTEM.
Syracuse Univ., NY. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 7C.
W90-09377

8C. Hydraulic Machinery

LOCAL INTELLIGENT PUMPING--A STANDARD APPROACH.
SPP Controls Ltd., Reading (England).
For primary bibliographic entry see Field 5F.
W90-08802

ROBUST DIGITAL CONTROL OF VALVES IN A LARGE WATER NETWORK.
Instituto de Ingenieria Cibernetica, Barcelona (Spain).
For primary bibliographic entry see Field 5F.
W90-08807

HYDROPOWER RESEARCH AND DEVELOPMENT IN MINNESOTA.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 6D.
W90-08989

8D. Soil Mechanics

SCALE MODEL OF THE LEAZ SLIPPAGE IN THE GENISSIAT RESERVOIR (ETUDE SUR MODELE REDUIT DU GLISSEMENT DE LEAZ DANS LA RETENUE DE GENISSIAT).
Compagnie Nationale du Rhone, Lyon (France).
For primary bibliographic entry see Field 8A.
W90-09058

8E. Rock Mechanics and Geology

SIMPLIFIED EARTHQUAKE ANALYSIS OF GATED SPILLWAY MONOLITHS OF CONCRETE GRAVITY DAMS.
California Univ., Berkeley.
For primary bibliographic entry see Field 8A.
W90-08762

WYNOOCHEE DAM FOUNDATION REPORT.
Army Engineer District, Seattle, WA. Seattle District.
For primary bibliographic entry see Field 8A.
W90-08774

TURKWEL HYDROPOWER PROJECT NEAR THE KENYAN RIFT VALLEY (EAST AFRICA).
Grenoble-1 Univ. (France). Inst. de Recherches Interdisciplinaires de Geologie et de Mecanique.
P. Antoine, A. Giraud, R. Huber, G. Lavedan, and P. Y. Moullard.
Engineering Geology EGGOAO, Vol. 28, No. 1/2, p 133-147, February 1990. 6 fig, 1 tab, 8 ref.

Descriptors: *Africa, *Arch dams, *Kenya, *Rock mechanics, *Rock properties, Concrete dams, Dam construction, Dams, Metamorphic rocks, Permeability, Petrology, Rock excavation, Seismic properties.

The Turkwel Gorge hydroelectric power plant, with a thin arch dam currently under construction, is located in a collapse zone of the great East African Rift. The rock formations found at the site range from metamorphic Pre-Cambrian schists and gneisses to granite intrusions. The geologic structure of the site is dominated by more recent events associated with the opening of the Rift during Tertiary time. Due to the complex geology and structure of the site, and the importance of tectonic processes on the engineering properties of the rocks, extensive geotechnical testing was conducted prior to dam design and construction. The origin and orientation of fracture patterns is particularly important in designing large structures. The investigation included petrologic analysis of the rock formations to ascertain stress fields, physical and mechanical testing of rock samples, permeability tests, collection of seismic data, dilatometer tests, and flat jacks tests. Engineering specifications were designed to address the problems posed by the proximity of the site to the Rift graben, and the fracture patterns imprinted by the tectonic history of the site. With the exception of a drainage system, the rock quality at the site is generally excellent and there have been no major problems with excavating and slope stability; excavation and disposal of the 40+ feet of overburden appears to be one of the major difficulties in developing the site. (Tappert-PTT)
W90-09036

8F. Concrete

SIMPLIFIED EARTHQUAKE ANALYSIS OF GATED SPILLWAY MONOLITHS OF CONCRETE GRAVITY DAMS.
California Univ., Berkeley.
For primary bibliographic entry see Field 8A.
W90-08762

8G. Materials

EXTRACTION OF ORGANOTIN COMPOUNDS FROM POLYVINYL CHLORIDE PIPE.
Georgia Inst. of Tech., Atlanta. School of Chemical Engineering.
For primary bibliographic entry see Field 5B.
W90-08651

8I. Fisheries Engineering

MATHEMATICAL MODEL FOR CADMIUM IN THE STONE LOACH (NOEMACHEILUS BARBATULUS L.) FROM THE RIVER ECCLESBOURNE, DERBYSHIRE.
Institute of Terrestrial Ecology, Huntingdon (England). Monks Wood Experimental Station.
For primary bibliographic entry see Field 5B.
W90-08669

GAS-BUBBLE DISEASE IN THREE FISH SPECIES INHABITING THE HEATED DISCHARGE OF A STEAM-ELECTRIC STATION USING HYPOLIMNETIC COOLING WATER.
Duke Power Co., Huntersville, NC. Applied Science Center.
For primary bibliographic entry see Field 5C.
W90-08686

PRODUCTION OF JUVENILE ATLANTIC SALMON, SALMO SALAR L., AND BROWN TROUT, SALMO TRUTTA L., WITHIN DIFFERENT SECTIONS OF A SMALL ENRICHED NORWEGIAN RIVER.
Rogaland Distriktshoegskole, Stavanger (Norway).
For primary bibliographic entry see Field 2H.
W90-08709

CHEMICAL FLUXES AND MASS BALANCES IN A MARINE FISH CAGE FARM. I. CARBON.
Chalmers Univ. of Technology, Goeteborg (Sweden). Dept. of Analytical and Marine Chemistry.
P. O. J. Hall, L. G. Anderson, O. Holby, S. Kollberg, and M. O. Samuelson.
Marine Ecology Progress Series MESEDT, Vol. 61, No. 1/2, p 61-73, March 1990. 7 fig, 4 tab, 31 ref.

Descriptors: *Carbon cycle, *Estuarine environment, *Fish farming, *Fish physiology, *Food chains, *Mass balance, *Organic carbon, Eutrophication, Growing seasons, Seasonal variation, Sedimentation.

Carbon fluxes in a marine trout cage farm in the Gullmar Fjord, western Sweden, were measured to investigate how much of the carbon supplied to the farm was recovered in harvest, how much was lost to the environment, and the properties and fate of this environmental loss. The measured fluxes included fish food, juveniles, harvest, fish loss (death and escape), sedimentation from the cages, and benthic release measured with diver-operated flux chambers and a gas collection unit in situ. Carbon mass balances for the farm, based on the measured fluxes (flux method), were constructed for each of two consecutive growing seasons. Another mass balance (accumulation method) was based on the total carbon input with food and juveniles to the farm since it was started, the removal of carbon with harvested fishes and fish loss, and the recovery of carbon in the sediment

originating from the farm after seven growing seasons. Some 21-22% of the total carbon input to the farm was recovered in harvest, fish loss constituted 1-3%, and 75-78% (or 878-952 kg carbon/ton of fish produced) was lost to the aquatic environment. On a seasonal basis and of the carbon input to the farm, solute release from the cages (probably carbon dioxide produced during fish respiration and excreted urea) removed 4-49%, sedimentation of feces and excess food removed 29-71%, flux from the farm sediment of dissolved and gaseous carbon (total carbonate, methane, and dissolved organic carbon) transferred 2-6% back to the overlying water, and 23-69% was accumulated in the sediment. (Ranges of values represent inter-seasonal variability.) The long-term (seven seasons) sediment accumulation of carbon amounted to 18% of the total carbon input to the farm. Of the carbon deposited on the sediment surface 3-20% was released back to the overlying water seasonally. Total carbonate dominated the annual benthic fluxes. Loss to the environment of dissolved carbon (the sum of solute release from the cages and benthic flux) amounted to between 6 and 55% of the carbon input to the farm on a seasonal basis, and 58% on a long-term basis. This study constitutes the first step in an assessment of the eutrophication caused by the fish farm. (Author's abstract)
W90-08739

ARCTIC GRAYLING COEXIST WITH DAM SAFETY IMPROVEMENTS.
HKM Associates, Billings, MT.
G. Elwell.
IN: Proceedings of the Symposium on Headwaters Hydrology. American Water Resources Association, Bethesda, Maryland. 1989. p 83-93, 6 fig, 14 ref.

Descriptors: *Dams, *Ecological effects, *Fisheries, *Grayling, *Headwaters hydrology, Fish behavior, Middle Creek Dam, Spawning, Water resources development.

The rehabilitation of Middle Creek Dam, located south of Bozeman, Montana, requires replacement of Arctic grayling spawning areas which will be inundated after raising the dam. Development of a mitigation plan required extensive analyses. The extent of current spawning was assessed. Methods for enhancing spawning further upstream were evaluated. A test spawning structure was designed and used to evaluate potential mitigation alternatives. A permanent mitigation plan was developed and performance testing has begun. While little research has been done on enhancing Arctic grayling habitat, work done with other species combined with an extensive field program resulted in design and construction of a test structure. Monitoring of this structure showed it is possible to successfully enhance spawning habitat for Arctic grayling. A permanent structure was designed and built, upstream of the proposed reservoir pool, based on test data, and preliminary hydraulic measurements indicate that Arctic grayling spawning should continue successfully after raising Middle Creek Dam. (See also W90-08822) (Author's abstract)
W90-08831

PROTECTING THE WET COMMONS.
Scripps Institution of Oceanography, La Jolla, CA.
For primary bibliographic entry see Field 6G.
W90-08940

NATURAL AND ANTHROPOGENIC FORCES ACTING ON A FOREST LAKE.
Minnesota Univ.-Duluth. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-08982

FISHERIES AND ENVIRONMENTAL RESEARCH BY THE MINNESOTA SEA GRANT COLLEGE PROGRAM.
Minnesota Univ., St. Paul. Sea Grant Program.
D. C. McNaught.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 110-112, Fall 1989. 3 fig, 20 ref. NOAA Grant No. NA86AA-D-SG112.

Descriptors: *Fisheries, *Lake Superior, *Limnology, *Minnesota, *Research, Fish management, Lamprey, Path of pollutants.

Minnesota's Sea Grant College Program has funded research on Lake Superior and outreach activities since 1977. Research results combined with public education serve the citizens, government, and businesses of the state. By funding academic research, the Sea Grant program has made major contributions to understanding the lake's fisheries and environment. Sea Grant provides management agencies with research results in an effort to restore some of the endemic species to the lake. Controlling the exotic lamprey, returning the lake trout to its dominant position as a predator, improving natural reproduction of lake trout, and managing the forage base are essential to this goal; Sea Grant is funding research in all of these areas to aid in developing more efficient ways of managing fish stocks. In addition, Sea Grant is funding research on various contaminants entering the lake and their effect on the lake fisheries. It has been found that algae take longer to absorb PCBs than previously assumed, which suggests that the techniques used to predict contaminant levels in fish may overestimate the amounts reaching fish through the food chains. (Tappert-PTT)
W90-08986

FISHERY RESOURCE OF THE UPPER MISSISSIPPI RIVER AND RELATIONSHIP TO STREAM DISCHARGE.
Wisconsin Univ.-Superior. Center for Lake Superior Environmental Studies.
W. A. Swenson, G. D. Heberling, D. J. Orr, and T. D. Simonson.
Journal of the Minnesota Academy of Science JMNAAC, Vol. 55, No. 1, p 144-148, Fall 1989. 2 fig, 3 tab, 11 ref.

Descriptors: *Bass, *Fish populations, *Minnesota, *Mississippi River, *Stream fisheries, *Streamflow data, Drought effects, Hydroelectric plants, Stream discharge.

Fish population data collected through the Northern States Power Company monitoring program near its plants at Monticello and Becker, Minnesota were analyzed to describe species diversity, changes in recreational fishing, fishing success, and the influence of stream discharge on smallmouth bass year-class success and abundance. The work is part of a more extensive effort to develop a model applicable in managing the upper Mississippi River to meet the growing needs of recreation, agriculture, communities, and industry. The monitoring program includes periodic analysis of 25 water quality parameters and daily measurements of stream discharge and temperature in the areas near the two power plants. Fish population data were collected in an area approximately 3 km upstream of Sherco to 5 km below the Monticello plant. Analysis of these data shows 48 species to be present and that smallmouth bass, Micropterus dolomieui, is the most important game species in the growing recreational fishery. Spring river discharges, measured at Monticello, range from over 40,000 cubic feet per second (cfs) in 1975 to 2,300 cfs in 1976. The drought of 1988 heightened awareness of the relationship between discharge and environmental quality. Comparison of smallmouth bass year-class strength estimates with stream discharge for the period 1973-1987, indicates strong year-classes develop during years characterized by low spring and summer discharge. (Tappert-PTT)
W90-08992

PRACTICAL APPLICATION OF THEORY FOR TIDAL-INTRUSION FRONTS.
Virginia Inst. of Marine Science, Gloucester Point.
A. Y. Kuo, R. J. Byrne, P. V. Hyer, E. P. Ruzecki, and J. M. Brubaker.
Journal of Waterway, Port, Coastal and Ocean Engineering (ASCE) JWPED5, Vol. 116, No. 3, p 341-361, May/June 1990. 8 fig, 2 tab, 18 ref.

Descriptors: *Entrainment, *Environmental impact, *Estuaries, *Mathematical models, *Oysters, *Tidal floods, Channel flow, Fisheries, Islands, Numerical analysis, Theoretical analysis, Water circulation, Water currents.

A simple theoretical model was applied to interpret the characteristics of an estuarine front that forms at the early stage of each flood tide off Newport News Point, in the lower James River, Virginia. The observed depths of diving of denser water at the front, and the upriver movement of the front are explained theoretically. The construction of a man-made island to facilitate port expansion was proposed for downriver of the front. Its effect on the flood current approaching the front was quantified with a vertically averaged two-dimensional numerical model. The theory was used to predict the impact of the proposed island on the frontal characteristics, particularly with respect to the entrainment and transport of oyster larvae to the lower portion of the water column, where net transport is upriver toward seed-oyster beds. Applications of the front theory, results of the numerical model, and oyster-larvae studies indicate that the transport capacity of the front would be markedly reduced by island construction at the proposed sites. (Author's abstract)
W90-09127

MAHSEER CONSERVATION: PROBLEMS AND PROSPECTS.
Garhwal Univ., Srinagar (India). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W90-09195

COMPARISON OF DISCHARGE METHODS AND HABITAT OPTIMIZATION FOR RECOMMENDING INSTREAM FLOWS TO PROTECT FISH HABITAT.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
D. J. Orth, and P. M. Leonard.
Regulated Rivers Research & Management RRRMEP, Vol. 5, No. 2, p 129-138, March/May 1990. 4 fig, 3 tab, 22 ref.

Descriptors: *Fish conservation, *Instream flow, *Stream discharge, *Stream fisheries, *Streamflow, *Virginia, *Water use, Base flow, Environmental protection, Habitats, James River Basin, Model studies, Montana method.

Reliable methods are urgently needed for recommending minimum instream flows to protect aquatic life. For basinwide planning purposes, simple methods, which require little or no field investigation, are required. While these methods tend to be conservative, the degree to which they protect habitat for fish is seldom determined. A physical microhabitat model (PHABSIM) was applied for nine target fish species in four streams in the upper James River Basin, Virginia, to (1) identify optimum flows to protect the fish fauna, (2) investigate the relationship between optimum flow and average discharge, and (3) compare the findings with recommendations based on simple discharge methods. Microhabitat availability for riffle-dependent species was most limited at low flows while microhabitat availability for pool-dependent species was most limited at high flows. At each study site there was a rapid increase in riffle habitat as discharge increased above zero. Optimum flow was the flow that maximized habitat for the most habitat-limited species or life stages. The recommended optimum flow increased with increased stream size but the slope was not constant; as stream size increased lower proportions of average discharge were required to maintain optimum habitat. Aquatic Base Flow recommendations (such as September median flow) provided varying, but reasonable degrees of habitat protection. The Montana method 10% recommendation corresponded to near optimum habitat in small streams but greater than optimum flow at the large stream site. Seven-day, 1-in-10-year low flows provide very limited amounts of physical habitat for riffle-dwelling fishes. The results provide a basis for making preliminary flow recommendations in this region with readily available data. Further studies will be needed to test the assumptions that need to be made. (Author's abstract)

Group 8I—Fisheries Engineering

W90-09250

9. MANPOWER, GRANTS AND FACILITIES

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LEGISLATIVE COMMISSION ON MINNESOTA RESOURCES INVOLVEMENT IN WATER RESOURCE PROGRAMS.
For primary bibliographic entry see Field 6E.
W90-08995

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EPA SUPERFUND DATA BASES ON THE OCCURRENCE AND DISTRIBUTION OF ORGANOCHLORINE PESTICIDES IN WATERS AND SOILS FROM HAZARDOUS WASTE SITES.
Viar and Co., Alexandria, VA.
For primary bibliographic entry see Field 7C.
W90-09453

10F. Preparation Of Reviews

RESOURCE COMPETITION OF HERBIVOROUS ZOOPLANKTON: A REVIEW OF APPROACHES AND PERSPECTIVES.

Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.).
For primary bibliographic entry see Field 2H.
W90-08722

NITRATE POLLUTION OF GROUNDWATER IN WESTERN EUROPE.
Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hanover (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W90-09257

PESTICIDE POLLUTION OF GROUNDWATER IN THE HUMID UNITED STATES.
Iowa Dept. of Natural Resources, Iowa City.
For primary bibliographic entry see Field 5B.
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W90-09045	5B	W90-09129	2L	W90-09213	2H	W90-09297	5C
W90-09046	5B	W90-09130	2H	W90-09214	5G	W90-09298	5B
W90-09047	5B	W90-09131	5A	W90-09215	5A	W90-09299	5B
W90-09048	5B	W90-09132	2H	W90-09216	5C	W90-09300	5A
W90-09049	2K	W90-09133	2F	W90-09217	5B	W90-09301	5B
W90-09050	2K	W90-09134	2F	W90-09218	5B	W90-09302	5A
W90-09051	2H	W90-09135	2F	W90-09219	5B	W90-09303	2B
W90-09052	5B	W90-09136	5B	W90-09220	5B	W90-09304	2B
W90-09053	2K	W90-09137	2F	W90-09221	2B	W90-09305	2B
W90-09054	5B	W90-09138	5B	W90-09222	2B	W90-09306	2B
W90-09055	5A	W90-09139	2K	W90-09223	2L	W90-09307	5E
W90-09056	2A	W90-09140	2F	W90-09224	2L	W90-09308	5E
W90-09057	2J	W90-09141	5B	W90-09225	2H	W90-09309	5G
W90-09058	8A	W90-09142	5G	W90-09226	2H	W90-09310	7B
W90-09059	6D	W90-09143	7A	W90-09227	2C	W90-09311	5B
W90-09060	5B	W90-09144	5G	W90-09228	2H	W90-09312	5A
W90-09061	2K	W90-09145	2L	W90-09229	5D	W90-09313	5A
W90-09062	2K	W90-09146	2K	W90-09230	5F		

Subject Fields

1. NATURE OF WATER

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3. WATER SUPPLY AUGMENTATION AND CONSERVATION

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5. WATER QUALITY MANAGEMENT AND PROTECTION

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